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THE JOURNAL OF THE AUSTRALIAN INSTITUTE OF AGRICULTURAL SCIENCE

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The Journal aims to publish material of interest to Agricultural Scientists, contributed by authors working in agricultural or related fields; authors need not be members of the Institute.

Contributions are of three types, namely: "Articles", "Technical Papers" and "Technical Notes". For information about the size and form of each type of contribution, see page 2 of the March, 1955, issue of the Journal.

Manuscripts should be double spaced and should be submitted in duplicate, as part of the delay in referring is then avoided.

For more detailed information concerning the preparation and lay-out of scientific papers, authors are referred to the C.S.I.R.O. publication "Guide to Authors" and to an article entitled "The Preparation and Editing of Technical Papers" by N. S. Noble, published in the Australian Library Journal, April, 1954. The policy laid down in these publications is also largely followed by this Journal.

In addition to the contributions described above, the Journal is pleased to publish "Letters", "News Items", "Talks" and "Personal Notes" which have been received from, or which are of interest to, members of the Institute.

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ARTICLES

THE ROLE OF THE INSTITUTE — A CHALLENGE

By H. C. FORSTER

"The Time has come, the Walrus said,
To talk of many things
Of shoes and ships and sealing wax
Of cabbages and Kings".

Our Charter

The Australian Institute of Agricultural Science celebrated its twenty-first birthday during last year and we can well say with the Walrus that the time has come to talk of many things—to review the achievements and shortcomings of our Federal Institute and to formulate if we can our aims for the future.

Many members are doing just this. They are asking, "What has the Institute done for me?", "Is my membership of the A.I.A.S. worthwhile?". A few others are asking, "What is the value of the Institute to the agricultural profession?" and the wider question, "What is the role of the A.I.A.S. in Australian agriculture?". These questions have been asked many times in the past and will be asked again in the future.

The Federal Institute is at a vital crossroads. It faces a challenge as indeed does each individual A.I.A.S. State branch. Is our only aim Service to Members, or have we not an equally important objective of service to the profession and practice of agriculture in Australia as a whole? There is no doubt as to the views of many of our members but it may be of value to some others to review the position.

May we go back to that meeting in January, 1935 in the Botanic Gardens, Melbourne, when Dr. A. E. V. Richardson gave the inaugural address at the installation of Professor Wadham as first President of the Australian Institute of Agricultural Science. As he said then, for the first time the several units of S.U.A.G.A., M.U.A.S., Waite Sciences Club, which had so ably served agricultural scientists in each state were brought together for the purpose, as the memorandum of association puts it, to promote and encourage the advancement of agricultural science as a profession and to further the interests of agriculture in the Commonwealth of Australia.

This marked an important stage from a number of points of view but the concept to stress here, and which was in the forefront of the minds of the framers of our articles, is that the Institute should not only be of service to members but should play its part in advising on the framing of a national policy in agricultural science and the agricultural profession in Australia.

This then was one of the aims, and in the formation of the Federal Council, the proxy council and the various State branches, the framers of our Constitution sought to set up the machinery by which we could achieve these aims.

What have we achieved?

In the process of time we have learnt a great deal of the difficulties of Federation as indeed our political leaders have also learnt in the bringing together of the several states into a Federal Commonwealth of Australia. We have come to realize that Australia is a very large country: that the interests and constitution of the branches in the respective regions differs and often will be at variance one with the other: that personal contact which is often the only way to resolve such differences is difficult and

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costly to arrange with the result that much of the business of a Federal Institute must be done by correspondence involving much paper work which often drags on interminably: that a national policy can often only be at best a compromise between conflicting interests. These difficulties are very real and will continue to be a handicap but this does not mean that we should necessarily abandon our efforts for surely we have achieved much in our short twenty-one years.

It is not possible here to present details of the many activities which the Institute conducts for the benefit of members, but stress should be laid on one or two broader aspects which have a bearing on the effectiveness of the Institute as an organization.

The Journal

Everyone will agree that our greatest success has been in the issue of the Journal of the A.I.A.S. Not only has this been a means of providing for publication of Institute activities and news about members, but it has also established itself as a Journal for publication of first class Australian research and investigation. The recent inclusion of general and review articles on agricultural matters meets a need not previously covered by any other scientific agricultural journal in this country. Its present circulation of 1,710 copies to countries throughout the world marks a very real achievement in service to members and to the agricultural profession.

Technical Conferences

In the technical field, the Institute is playing an increasingly important part in organizing conferences and discussion groups. The Refresher Schools conducted by the Victorian branch in conjunction with the University have been most valuable. Symposia on "The Roles of C.S.I.R.O., the University and the Department of Agriculture in Research and Extension" by the N.S.W. Branch; on "The Development of Scientific Agriculture in Victoria—Past and Future" by Victoria and recent moves for the Institute to play a leading part in assisting A.N.Z.A.A.S. to organise the programme for Section K Agriculture are three excellent examples.

Educational Conferences

In the educational field, three symposia again come to mind—"Rural Universities" and "The Curriculum in Agricultural Science" both of which were organised by the N.S.W. branch and "The Recruitment and Training of Agricultural Scientists" by the Victorian branch. The Institute can also rightly claim that the recent decision by the University of Melbourne to establish a Degree course in Agricultural Engineering was largely the result of publication of the report of an Institute committee pointing out the deficiencies in teaching and research in this subject.

Recruitment and Employment

The most important field of recruitment and employment of agricultural scientists is one which has occupied the attention of the Institute to a considerable degree. The need for increased numbers of graduates was stressed by the Institute and a number of other organizations some four or five years ago, and active steps were taken to increase the interest of school children in agricultural science. The Brochure 'Careers in Agricultural Science' was prepared and distributed throughout Australia, and publicity, radio talks and addresses were given to schools. While undoubtedly the Institute's activities alone were not entirely responsible nevertheless the increase in the number of first year students in agricultural science in Australia from 130 in 1953 to over 300 in 1957 is undoubtedly indicative of the very important part that the Institute can play in matters of national policy concerning agriculture.

The fact that the number of positions available to agricultural graduates in some State Departments of Agriculture has decreased recently is surely indicative of the need for constant review of the position by an authoritative body and who

other than the Institute is in a more favourable position to do this? We can rightly claim that the Institute's part in this field is being recognized by outside organizations.

Recognition

The fact that the Standing Committee on Agriculture has agreed that the Institute is the appropriate impartial body to assess from time to time the overall need for agricultural scientists, is recognition by an official Commonwealth body of the increasing status of the Institute in the community.

Further evidence of this recognition is afforded by the fact that the Commonwealth Department of Commerce and Agriculture provided the quite considerable sum of £4,000 over a period of three years to support the Institute's activities and the Rural Credits Fund of the Commonwealth Bank has contributed £200 towards the cost of the Journal during each of the past five years. The recent appeal to Industry for similar financial support of Institute activities met with a quite outstanding success and an amount of £4,300 has been received to date with further promises of £1,095 for 1957-'58. Members can take this as recognition not only of the important part that Agricultural scientists can play in the commercial world at the present time, but also of the fact that the Institute is the appropriate body to take the lead in this field.

The Challenge

These facts which can be supported by many other examples clearly illustrate the field envisaged by our founders as typical of the part which the Institute can play in promoting interest in agricultural science and in raising the status of the agricultural profession. We have just touched on the fringe so far and it remains with the members of the Institute to decide whether we take up the challenge and develop further or content ourselves only with the very important but more restricted field of providing facilities and services to members.

If we accept the latter, there is little need for our Central Secretariat nor for anything more than a token Federal Council.

However, if we decide to accept the challenge, we will have to do some solid thinking, not only as to what we should do in the future but also as to the means by which we can most efficiently do it. Our experience over the past three years shows that we must think again on the organization that is needed to cope with the demands that are made on the overburdened honorary officers of the Institute. It is essential not only to look at the question of staff and our financial resources but also to examine closely our organization of Federal council in relation to State branches; to investigate the ways and means whereby the Central Secretariat can be of greater assistance to State branches, and matters of a similar nature.

The Agricultural Institute of Canada

Discussion with the leaders in the Agricultural Institute of Canada at Ottawa last year indicates that we can gain a great deal by looking closely at the organization and activities of that body.

Founded in 1920 as the Canadian Society of Technical Agriculturists, the Agricultural Institute of Canada came into being under that name as a result of a reorganization in 1945. Those who were responsible for its formation believed that professional agriculturists had failed to contribute as much as they should have to Canadian agriculture because lacking a national organization they were unable to speak authoritatively as a representative body.

In the beginning members were grouped in local district centres rather than as State branches as in Australia and the Dominion Executive Committee was made up of one representative from each centre. Provision was made in the early years for the grouping of members into subject sections on a national scale and for affiliation of scientific societies which had as one of their main objectives, the

advancement of a branch of agricultural science.

Reorganization took place in 1945 when Provincial or Regional Councils were established as groups of a number of the smaller district centres. These Councils had administrative authority over their specific areas in much the same way as our State branches here. The Charter remains in much the same form as framed by the original 1920 convention and is not very dissimilar to our own.

Development

Four fairly well defined stages have so far marked development of the A.I.C. In stage one, formation, expansion and consolidation occurred and emphasis was placed on raising academic standards, expanding the agricultural services, widening employment opportunities in industry and obtaining a greater degree of professional recognition.

The second stage came in the late thirties and was concerned with establishing legal professional status for independent practising agricultural scientists. This avenue of activity has not yet been developed to any degree in Australia but it may well become important in the future. La Corporation des Agronomes was incorporated under the Quebec Act of 1942 as a separate organization to the A.I.C. and aroused considerable interest in the other provinces.

Stage three was introduced with the reorganization of the older Canadian Society of Technical Agriculturists and under this the various professional agricultural bodies were once more affiliated as Agrologist Institutes with the national body.

Stage four, from 1944 onwards, has been concerned in bringing uniformity between the various Agrologist Institutes through a body with the rather forbidding title of the Coordinating Advisory Committee on Professionalization.

Federal-State Branch Relations

It is interesting to look rather more closely at the relationship between the national body and the branches. The latter are the active units concerned with recruiting members, publicizing activities and programmes, considering local problems in much the same way as the State branches do in Australia. It is a recognized principle in A.I.C., as here, that the strength of the National body lies in the degree of interest which local branches take in both their own and national problems.

The national body considers its function is to clarify ideas and theories on a wide variety of agricultural subjects of direct concern to the agricultural profession such as: academic standards, research and extension, conservation and land use, professional status, employment opportunities, supply-demand relationship for agricultural graduates, salary scales and superannuation.

The A.I.C. provides a national meeting ground at its annual convention for scientific and technical workers to come together to discuss matters and formulate professional policies.

It provides at this meeting facilities for the affiliated scientific societies to meet and hold their technical discussions.

The A.I.C. as the representative national body speaks to the public with one voice on agricultural matters and draws public attention to the agricultural profession.

It provides direct services to members including publications, both scientific and technical, textbook purchasing and employment services, and an information and consultation service.

The A.I.C. is now in its thirty seventh year, has a membership of over 3,500 members, some 28 branches and a full time Secretary and staff of five others to carry out the administrative work of the Institute. This body thus is a splendid example of achievement not only in service to members but also in fulfilment of the wider aim of service to the profession and the country.

Future Development of Our Institute

A healthy active Federal Institute must depend on healthy active State branches

which in turn must promote interest and encourage activity in individual members.

The prime function of the Federal Council is to be aware of and define the broad problems that concern the profession and national agriculture and then to obtain the views of regional committees and attempt to mould these into an Australian view.

Many bodies such as Government departments, farmers' organizations already do just this. The value of the A.I.A.S. should be that it can present an impartial view from people trained to think logically. It may well be that final action on agricultural matters should be decided on political or financial grounds but it is important that the impartial scientific view should be stated clearly, and the Institute is the one body to do this.

The Federal Council must therefore not only define the problems but it must also provide the facilities to State branches to enable them to function smoothly and without too much burden on their already overloaded honorary officers.

Now how should the Council and the State branch achieve the interest and active support of the individual member? Without doubt in the first case by supporting him in his right to fair working conditions and salary, and secondly by providing him with the means for social contact with his fellow workers and organizing interesting lectures at regular intervals.

But the more active participation by a member is necessary if he is to feel that he is really playing a part in the Institute.

The Victorian Branch committee is convinced that the enthusiasm and vigor of the branch as a whole can largely be put down to the fact that some fifty members (12 per cent. of its total membership) are playing an active part on one or other of its 14 subcommittees.

There is then a need for a more active policy of arranging discussion symposia on matters of regional or national importance. If organized efficiently, these can provide for active participation by large numbers of people who would otherwise never be able to speak their mind publicly.

Much of our present activity is designed for the city member, and facilities for country members are poor. There are many regions in our states where fairly large groups of graduates are loosely bound together. Formation of sub-branches with regular meetings would be difficult to organize but interest of the members in the Institute and of the general public in the agricultural profession would be encouraged by the holding of social gatherings, meetings and addresses in country areas.

On the scientific and technical side, the Federal Institute is starting to play a more active part in its recent endeavour to assist in arranging the agenda for A.N.Z.A.A.S. Much more can be done, but it is doubtful whether the Federal or State Councils are the best people to arrange the scientific aspects and programme. Perhaps consideration could be given to setting up within the Institute sub groups on the various scientific fields. This move has been anticipated in some fields already by formation of outside societies with a potential loss of members to the Institute. Could we not amend our constitution to include these as associated bodies, the Institute looking after administration details and the society specializing on the scientific aspects? As in the case of the A.I.C., the agricultural profession would then still speak with one voice on public matters and approaches to Government bodies through the Institute.

If plans along these lines can be implemented the Federal Institute will really consolidate its position not only with its members but also in establishing the agricultural profession in the eyes of the nation.

Recommendations

The council may like to give consideration to these specific suggestions:—

(1) The President's term of office would be of greater value to the Institute

if he were associated with the Council for a year immediately before taking office. Might it not be a sound idea to create the office of President-elect as a member of Council? If the President could be chosen twelve months before he takes office, and then as a member of Council gain a knowledge of current Institute business at the end of that period he would be much better prepared for his term of office.

(2) Mention has been made of the fact that the A.I.C. is based on small branch units which were later built into provincial groups. In reverse we would gain much by forming more sub-groups within our State branches. A loose, perhaps entirely informal sub-branch in country districts would be of great value to our country members who rightly claim that often they are on the thin end of the stick as compared with city members, and the State or Federal Committee might well finance speakers to attend meetings or social gatherings from time to time. The Australian Veterinary Association has established several very successful groups of this type.

(3) The question of affiliated societies has been well to the fore in discussions in the Institute in recent months. The Institute ought to have an active programme of technical sub-groups within the Institute. If in the case of those societies already formed the Institute could offer to undertake the administrative problems of collecting fees and organizing meetings at a convenient time such as at A.N.Z.A.A.S., it may well be that the new groups, which will undoubtedly have to face administration problems and higher costs as they expand, would be encouraged to remain closely associated with the Institute. The latter would then still be able to speak on broad policy matters for agricultural scientists generally.

(4) If we are to accept our challenge and add to the responsibilities of the Institute the time would be opportune for a thorough examination of the functions and organization of our central administration, not that I wish to infer that they are not performing an excellent service at the present time. The Federal Council or the Proxy Council would have difficulty in carrying out such a review in their normal one day meetings, and the appointment of a sub-committee of Council as a Committee of Enquiry with advice from outside specialists is worthy of consideration. The terms of the charter for such a committee might well include such questions as, "How can the Central Secretariat be of greater service to State branches?". "Can business between Federal and State branches be speeded?" "Should the Central Executive be strengthened?".

(5) As a final point on the mundane question of subscription, there appears to me to be much merit in a sliding scale of fees whereby young graduates on lower salaries would contribute less than older members of the profession.

In Conclusion

The members and branches of the A.I.A.S. are facing at the present time the decision to accept or refuse the challenge to play a decisive role in framing a national outlook on agricultural science. If we accept we must be prepared each one to play his part, whether it be as a member of the Council, as a member of a State committee or merely as an ordinary member of the Institute. There must be no doubt that the Institute can and will play a great part in our Australia which depends so much on its primary industries.

The question for each member is not "What has the Institute done for me?", but "What can I do for the Institute?"

(Received for publication, April 24, 1957).

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NITROGEN FERTILIZER IN AUSTRALIAN AGRICULTURE

By J. S. RUSSELL

Nitrogen fertilizer occupies a very minor place in Australian agriculture at the present time. This is in spite of the fact that nitrogen is the key element in crop nutrition and that Australian soils as a whole are as deficient in this element as any comparable soils in the world. Moreover consumption of nitrogen fertilizers over the last twenty years in Australia has increased much less than in other parts of the world, where, in some instances, increases have been spectacular. This paper analyses some of the present trends overseas with regard to nitrogen as a fertilizer, postulates some reasons for the low consumption in Australia and discusses the possibilities of increases in nitrogen fertilizer consumption in the near future.

Overseas Trends

One of the most significant developments in world agriculture during the post-war era, has been the large increase in the use of nitrogen fertilizer. This change has not been confined to any one country but seems to have been almost universal. Table I shows the changes which have occurred in world consumption and in the United States, United Kingdom and Canada as compared with Australia over the last few years.

TABLE I.

Nitrogen fertilizer consumption in thousands of metric tons of primary nitrogen (*F.A.O.* 1955; *Page* 1955).

Year	World	United States	United Kingdom	Canada	Australia
1938	2515	346	60	10.0	13.0
1946-47 ..	2400	711	142	26.2	10.8
1950-51 ..	3900	1157	205	31.2	17.1
1954-55 ..	5800	1776	243	46.0	21.1
1955-56 (est.)	6100	1798	261	46.0	21.5

Almost a fivefold increase has occurred in the United States where nitrogen fertilizer consumption increased from 346,000 tons of primary nitrogen in 1938 to 1,776,000 tons in 1954/55. The increase in the United Kingdom was of the order of a fourfold increase from 60,000 tons in 1938 to 243,000 tons in 1954/55. Even in Canada which, like Australia, uses relatively small amounts of nitrogen fertilizer over a fourfold increase has occurred in the post-war era. During this period Australian consumption increased from 13,000 tons in 1938 to 21,000 tons in 1954/55.

Much of the increased use of nitrogen fertilizer in countries overseas has been associated with an increase in fertilizer consumption generally. However in most areas there has been a noticeable increase in the relative amounts of nitrogen used when compared with the other major nutrients, phosphorus and potassium. This can be seen from an examination of Table II.

TABLE II.

Relative amounts of nitrogen, phosphorus and potassium fertilizers used in 1938 *and* 1954/55 *in terms of primary nutrients* (*F.A.O.* 1955; *Page* 1955).

Country	1938	1954/55
	$N:P_2O_5:K_2O$	$N:P_2O_5:K_2O$
United States ..	1 : 1.95 : 1.03	1 : 1.14 : 0.91
United Kingdom	1 : 2.83 : 1.25	1 : 1.40 : 1.03
Canada	1 : 3.64 : 2.12	1 : 2.28 : 1.67
Australia	1 : 17.1 : 0.48	1 : 20.0 : 0.74

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These changes in relative amounts have not occurred suddenly but have rather been the result of a slow progressive tendency over the last 10 years or so. The change has been particularly marked in the United States where the $N:P_2O_5:K_2O$ ratio changed from 1:1.95:1.03 in 1938 to 1:1.14:0.91 in 1954/55, but has also been quite noticeable in the United Kingdom and Canada. In Australia on the other hand the great preponderance of usage of phosphorus over nitrogen fertilizer has actually shown a small increase. Potassium fertilizer also has shown a small increase in relation to nitrogen fertilizer consumption.

One of the main features of the growth of nitrogen fertilizer usage overseas has been the increase in production of forms other than ammonium sulphate. Ammonium sulphate has in the past been the main form of nitrogen fertilizer produced, since not only is it a by-product of industrial plants such as steel and gas but also it is produced synthetically. The total amount produced still exceeds that of any other solid form of nitrogen fertilizer but its percentage share of world production has been gradually decreasing.

Ammonium nitrate has shown increases in recent years and at the present time is second only to ammonium sulphate in total amount produced. It has the advantages of a higher percentage of nitrogen (33.5 per cent. compared with 20.5 per cent. for ammonium sulphate) and the fact that nitrogen exists in both the ammonium and nitrate forms. A major problem which originally restricted usage of ammonium nitrate, namely its tendency to absorb moisture, has been largely overcome with suitable conditioning agents.

A more recent trend particularly in the United States has been the increased production of liquid forms such as a anhydrous ammonia which have tended to supersede the more traditional solid forms. In 1955, 51 per cent. of the total nitrogen produced in the United States was anhydrous ammonia, but only a part of this was applied directly to the soil, most of it being used in the ammoniation of superphosphate. There has also been some increase in the use of nitrogen solutions which have been found useful under certain conditions.

Production and Consumption of Nitrogen Fertilizer in Australia

Production of nitrogen fertilizer in Australia is still confined almost entirely to ammonium sulphate. During the year 1955/56 71,000 long tons of ammonium sulphate (equivalent to 14,900 metric tons primary nitrogen) was produced, 46,000 tons coming from Government munition factories, 19,000 tons from steel works and 6,000 tons from gas works. Although increases in production have occurred over the last few years the supply has been insufficient for Australian requirements and imports have been necessary. The amount imported has varied from as low as 350 tons in 1953/54 to as high as 43,000 tons in 1950/51. Some sodium nitrate has also been imported averaging 10,000 tons per year over the last few years and totalling 14,000 tons in 1955/56. Additions to the ammonium sulphate production capacity in Australia have occurred recently with a new factory at Risdon, Tasmania, having a potential of 55,000 long tons of ammonium sulphate per annum (11,000 metric tons of primary nitrogen). This may considerably alter the necessity for imports.

Consumption of nitrogen fertilizer in Australia has shown only small increases over the last few years. It is difficult to obtain detailed information from official statistical records as such information on fertilizers in Australia is confined to two categories "superphosphate" and "other artificial fertilizers". However, some information is available from trade sources and Table III shows the consumption of nitrogen fertilizer by States during 1955/56.

Of the various crops sugar cane uses by far the greatest amount of ammonium sulphate. In 1955/56 almost 41,000 tons or 43% of total Australian consumption

TABLE III.

Consumption of nitrogen fertilizer in Australia by States 1955/56.

State	Ammonium sulphate consumption	Consumption expressed as primary nitrogen	Percentage of total Australian consumption
	long tons	metric tons	%
Queensland ..	58,640	12,200	62
N.S.W.	13,780	2,870	14
Victoria	11,020	2,290	11
Sth. Australia	6,120	1,270	6
W. Australia	3,800	790	4
Tasmania . ..	2,410	580	3
Australia . ..	95,770	20,000	100

was used on this crop. Market garden crops, citrus, stone fruits and potatoes make up for most of the remaining amounts used. Green fodder crops also use some nitrogen fertilizer but usage of nitrogen fertilizers on cereals, except rice, is very small and on pastures negligible.

Factors Affecting Usage of Nitrogen Fertilizer in Australia

The relatively low consumption of nitrogen fertilizer in Australia when compared with other countries cannot be attributed to any one factor. Rather it is associated with several factors the most important of which would appear to be (1) economic factors (2) results achieved with legumes and (3) lack of large areas of intensively cultivated crops other than cereals. Other factors particularly the chronic under-supply of nitrogen fertilizer which has existed for many years may have had some effect but it is believed that nitrogen consumption in Australia can be best considered in the light of these three factors.

(1) *Economic factors*

The criterion of use of any fertilizer is the margin between the cost of the fertilizer and the return obtained from increased yields brought about by the fertilizer. Moreover any change in either the cost of the fertilizer or the price obtained for the crop may affect the usage of the fertilizer through its effect on the margin between costs and returns.

High cost of nitrogen fertilizer in Australia has undoubtedly been a factor in restricting its usage. Table IV shows the relative prices of ammonium sulphate in some of the major consuming countries as compared with Australia.

TABLE IV.

Wholesale price of ammonium sulphate in various countries in 1954. (*F.A.O.* 1955).

Country	U.S. Dollars per metric ton
United States	47.2
United Kingdom	48.4
West Germany	57.4
Japan	63.0
Australia	79.0

Thus the cost of ammonium sulphate in Australia is much higher than in other countries. It is also necessary to consider that the returns received for many Australian products are lower than in these countries. Wheat is a good example of this. In Australia the farmer receives approximately 13/- per bushel for wheat. In the United States, on the other hand, farm subsidies for wheat are paid which bring the return to the grower to almost 20/- per bushel. Under these conditions of lower cost of nitrogen fertilizer and higher returns for crops a wheat grower in the United States need obtain less than a 1.5 bushel increase in yield to cover the cost of the addition of 1 cwt of ammonium sulphate. On the other hand a wheat grower in Australia must obtain over 3 bushels increase in yield before covering the cost of the addition of 1 cwt of ammonium sulphate. Thus application of nitrogen fertilizer is a much more doubtful proposition and often alternative methods of supplying nitrogen are used.

(2) *Results Achieved with Legumes*

The widespread usage of legumes, in Southern Australia particularly, can be

attributed, firstly, to the presence of large areas of infertile soils in the higher rainfall areas and, secondly, to the development of suitable legumes, notably subterranean clover, which will thrive on these soils provided deficiencies of phosphorus and in some cases sulphur and minor elements are made good. These two factors have combined so successfully and given such satisfactory results that many Australian agronomists have come to think solely in terms of legumes when considering the nitrogen requirements of all soils.

However, it is important that the difference in behaviour of legumes on fertile and infertile soils be recognised. Donald and Williams (1954) showed that subterranean clover raised the nitrogen content of some podsolic soils from 0.085 per cent. to 0.139 per cent. over a period of years but it was certain that as the nitrogen content of the soil increased the actual quantity of nitrogen fixed per unit weight of clover grown decreased. Also Willoughby (1954) showed that subterranean clover under field conditions makes more use of soil nitrogen and less of rhizobial nitrogen as the soil nitrogen status is raised. These results are well in agreement with the observed behaviour of legumes when grown on soils of initial high fertility. Evidence has been brought forward (Lyon and Bizzell 1934) that in soils of high total nitrogen legumes appear to add little to the total nitrogen content and that in some cases there may even be a loss of nitrogen. This is particularly the case where the legume, such as lucerne, is removed as hay. Thus in high nitrogen status soils the large annual additions of nitrogen by legumes which is observed in infertile soils is by no means achieved. In most cases the additions are quite small and in some cases there may actually be some losses in total soil nitrogen.

These facts tend to explain why in Australia where the areas of infertile soils are immense and the areas of high fertility soils restricted to localised pockets (in a geographic sense) a school of thought based on the use of legumes for nitrogen requirements has developed. Similarly they explain why in the United States, for example, where there are large areas of fertile soils a school of thought based on the application of nitrogenous fertilizers to the soil has developed. This is not to say that nitrogen fertilizer is completely overlooked in Australia or that legumes do not play an important part in many phases of American agriculture, but broadly speaking it sums up the position with respect to the way agronomists approach the question of nitrogen requirements for crops.

Other factors certainly influence the emphasis on legumes in Australia as opposed to the extensive use of nitrogen fertilizer in the United States. One of them is the ease with which livestock husbandry can be carried out in Australia. Compared with the rigorous climatic conditions in the United States, involving sheltering and hand feeding of animals it is a relatively easy pursuit. Also prices for livestock products in recent years, particularly wool, have favoured pastures as opposed to cropping. Another factor which has affected the influence of legumes versus nitrogenous fertilizers is that in the United States legumes of comparable efficiency and adaptability to subterranean clover are not available over large sections of the country.

Nevertheless it would appear that the different approach to satisfying the nitrogen requirements of plants in Australia and the United States stems largely from inherent environmental conditions of soil and climate. Because of this the overall position is unlikely to change. In Australia over large areas of high rainfall-low fertility soils legumes present the only possible way of raising the fertility status and it is doubtful if nitrogen fertilizer will ever have a place in these areas. The realisation of this should not obscure the fact that in some areas, particularly those of medium soil fertility and high rainfall, and in irrigation areas, nitrogen fertilizer may be more suitable

for satisfying the nitrogen requirements of crops than legumes.

(3) *Lack of Large Areas of Intensively Cultivated Crops*

The area of land in Australia used for cultivated crops is very small in relation to the size of the continent and indeed even in relation to the area of higher rainfall country. What is probably more significant is that of this small area 50 per cent. is sown to wheat and 20 per cent. to oats and barley. Moreover much of the area cut for hay and green forage (20 per cent. of the total cultivated area) is cereal in origin. Thus no more than 10 per cent. of the cultivated area in Australia is devoted to what can be termed the more intensively cultivated crops. Of these the most important are sugar cane, orchards, market gardens, vineyards and potatoes. Since the area of cultivated crops approaches 20,000,000 acres no more than 2,000,000 acres is devoted to intensive crops.

Almost all the nitrogen fertilizer used at the present time is applied on intensively cultivated crops. Even on these crops usage is frequently much lower than on comparable crops in other countries. The average annual application of nitrogen fertilizer to potatoes in Maine (Hawkins *et al.* 1947) is 100-120 lbs N/acre (equivalent to 5 to 6 cwt of ammonium sulphate per acre). Similar dressings are used in California (Lorenz *et al.* 1954). In South Australia, on the other hand, applications to potatoes of more than 40 lbs N/acre (equivalent to 2 cwt of ammonium sulphate) are rare and the average application is probably less than 20 lbs N/acre (1 cwt ammonium sulphate).

Therefore, not only is the area of cultivated crops in Australia quite small but the great preponderance of cereal crops results in a very small area of intensive cultivation. This small total area plus the fact that applications by overseas standards are frequently low explains in some measure the small total amount of nitrogen fertilizer used in relation to other countries.

Future Use in Australia

Future trends in nitrogen consumption in Australia can be considered in the light of those factors which in the past have restricted its usage.

Economic Factors

In any discussion of the place of nitrogen fertilizer in Australian agriculture one cannot escape the overriding importance of the economic factor. The relation between cost of fertilizer and returns of products is the final criterion for determining the use of any fertilizer. As shown earlier the cost of nitrogen fertilizer in this country is much higher than elsewhere and this, combined with the fact that prices received for Australian products are often lower than overseas, has tended to reduce the profit margin and restrict usage. Any move, therefore, to bring the cost of nitrogen fertilizer in Australia more into line with that received overseas could result in greatly increased consumption.

However, even at the present price of nitrogen fertilizer there appears to be scope for increased usage. On many intensive crops where some nitrogen fertilizer is already applied heavier dressings than are used at present would be quite profitable. Some recent work in Tasmania on potatoes may be quoted in this respect (Wilson 1953).

Strong and Saxon (1954) have discussed another aspect of the economic factors governing the application of nitrogenous fertilizers. They question whether the changed price relations between nitrogenous fertilizers on the one hand and of the rural and pastoral products on the other, as compared with the relationship characteristic of the 1930's is fully realized. The extent of this change was much greater several years ago than now and varies with different crops. Thus, with sugar cane there has been little change from the relative price levels which existed in the 1930's. If anything,

price of fertilizer has risen more than returns from sugar cane. In the case of cereals, on the other hand, the change has been quite marked. For instance, Wark and Cook (1939) examined the economic aspects of application of nitrogen fertilizer to barley and oats. At this time the price received by the farmer for barley was 2/3 per bushel and the cost of ammonium sulphate was 12/- per cwt. The present price of ammonium sulphate is 38/- per cwt. Barley prices vary as to type and quality but in 1952/53 were as high as 16/2 per bushel. Present prices are lower than this and the final price received by farmers for 1955/56 is likely to be about 11/- per bushel. Even at these lower prices there is still a considerable change from the relationship prevalent in 1938 and under these conditions a much smaller response to fertilizer is necessary to cover the cost of the addition of nitrogen fertilizer. Similar changes could also be cited for other crops and it would appear that a revaluation of much early data on economic aspects of nitrogen fertilizer application using present price levels would be well worthwhile.

Efficiency of Legumes as Compared with Nitrogen Fertilizer

Emphasis in Australia has been greatly on the side of legumes for satisfying the nitrogen requirements of plants. Soil and climatic conditions over large areas are such that permanent pasture is the only possible form of agriculture and legumes the only feasible means of supplying nitrogen. Some cultivated crops may be grown from time to time mainly for renovating the pasture and making use of reserves of organic matter built up during the period of ley. Obviously nitrogen fertilizer has little place in these areas in the foreseeable future except possible for specialised purposes which will be referred to later.

Nevertheless the excellent results achieved with legumes in these areas should not obscure the fact that there are areas where the fertility level and moisture conditions are such that the nitrogen accretion from legumes may not completely satisfy the requirements of crops for nitrogen. Supplementary usage of nitrogen fertilizer needs much more consideration than has been given in the past.

The relative value of legumes as compared with nitrogen fertilizer has undergone a much more critical examination in the United States that it has in Australia. Considerable difference of opinion exists but some American workers believe that on level productive land legumes as an integral part of grain rotations are unnecessary. Bray (1955) has expressed the opinion that the primary objective of legumes, i.e., fixing nitrogen, can be carried out more cheaply by fertilizer nitrogen, and that secondary objective of legumes, i.e., providing protection from erosion and organic matter for soil conditioning, can be better served by grasses. To any Australian agronomist steeped in information on the advantages of subterranean clover such a statement is nothing less than heresy. Yet it is important in evaluating this statement to consider the difference in efficiency of legumes on fertile and infertile soils and also to appreciate that much of our thinking on legumes is conditioned by the spectacular results achieved on low fertility soils. Areas in Australia which compare with those discussed by Bray are not large but there is some scope for a critical assessment of the efficiency of legumes as compared with nitrogenous fertilizers, particularly on areas of more fertile soils and on irrigated soils.

Special consideration should be given in the irrigation areas not only to the relative efficiency of legumes but also to the overall pattern of land use. In Australia irrigation areas are notable for the high percentage of land in pasture. Thus of the 1,600,000 acres of land under irrigation in 1953/54 no less than 63 per cent. was devoted to pasture. Since the areas in Australia where intensive agriculture is possible are quite few the ques-

tion arises whether these resources of fertile soils and favourable moisture conditions could not be used more effectively with intensive cultivation of crops. It is realised that some of the area irrigated is under a system of water-rights which precludes almost any other form of land use. Yet it is a fact that under conditions of favourable moisture, fertile soils and high temperatures, the scope for crop production is very great, particularly where sufficient of the major plant nutrients have been applied. This approach is being used at the present time in the United States where yields of maize under irrigation as high as 150 bushels per acre are by no means uncommon (Paschal and French 1956). The problem of what cultivated crops could be grown in the irrigated areas is determined not only by crop adaptability but also by the availability of markets. Summer growing coarse grains such as maize, millet and sorghum, would appear to warrant most consideration. Another aspect worthy of attention is the development of high yielding cereal varieties which are specifically bred for growing under irrigation conditions. Practically no work on this aspect has been done in Australia and present dry land varieties under irrigation are likely to have a ceiling yield of 60-75 bushels per acre. Some interest is being shown overseas (Ramig, personal communication) in the use of Chinese and Korean semi-dwarf varieties as breeding material for the production of wheats especially suited for optimum moisture and soil conditions including adequate amounts of nitrogen.

Thus, great as is the value of legumes in providing a source of nitrogen, it is important that they should not be considered sufficient for plant requirements under all conditions and that the opportunity for using inorganic sources of nitrogen should not be overlooked.

Use on Intensive Crops

Increased use of nitrogen fertilizer on intensive crops can arise from two causes. First, from increases in amounts of nitrogen fertilizer applied to those areas which at present use some nitrogenous fertilizers and second, to an increase in the actual area of intensive cultivation carried out. As discussed earlier there appears to be scope for increases in the amounts applied but applications will be governed to some extent by economic conditions and also by the emphasis placed on nitrogenous fertilizers by extension authorities.

With regard to the second factor, i.e., increasing the area of intensive crops, it is significant that the crop production targets set by the Australian Agricultural Council for 1957/58 include large increases for what can be considered as intensive crops and much smaller increases for cereal crops. Such changes as occur will undoubtedly be slow and gradual but population increases will require greater areas to be devoted to such crops as vegetables which use large amounts of nitrogen fertilizer. Another development which could greatly increase nitrogen consumption is the success of the rice-growing project in the Northern Territory. If the projected acreages are attained substantial amounts of nitrogenous fertilizers will be required.

Use on Cereal Crops

As more than 80 per cent. of the cultivated area in Australia is devoted to cereal crops for both grain and hay an evaluation of these areas must also be made in considering the future usage of nitrogen fertilizer. At the present time practically no nitrogenous fertilizers are used on the 16,000,000 or so acres which are sown to these crops. Nitrogen requirements are met by breakdown of reserves of organic nitrogen present in the soil. Until the early 1940's little attempt was made in the cereal growing areas of South Australia to add to or even maintain the organic reserves in the soil. Thus there was a steady decline in the total nitrogen content of these soils which resulted in reduced crop yields (Cornish 1949) and also was associated with a deterioration in soil structure (Clarke and

Marshall 1947). In recent years many steps towards maintaining and increasing the organic matter have been made with longer rotations, increased use of livestock and the inclusion of ley periods, often with legumes. Although no overall survey has been made it is believed that the decline in organic nitrogen content has been arrested and that in some areas increases are occurring.

Fallowing has, of course, been the traditional means whereby mineral nitrogen for the growing crop has been made available from organic reserves. In addition to making nitrogen available for crop growth fallowing also has the advantage of conserving soil moisture in the sub-soil and ensuring the preparation of an adequate seedbed. Other advantages such as disease control may also be applicable in certain areas. However, against these advantages must be set the disadvantages of fallowing. Probably the most important of these is the fact that the bare surface of the soil is exposed to the wind and rain for long periods. In fact much of the serious soil erosion in Australia, both wind and water, can be laid at the door of fallowing. Other disadvantages include the fact that land is lying idle and unproductive for many months (most serious where livestock is an integral part of cereal growing) and also that fallowing is an exploitative process in that nutrients made available come from the reserves in the soil. Measures are available to overcome some of these deficiencies of fallow including cloddy surfaces during periods of high intensity rains or winds, stubble mulching, etc., but many of the disadvantages still remain.

Some recent work (Drover 1956; Newton and Drover 1956) in Western Australia highlights the soil depleting effects of fallow as compared with cropping and points to the need for a revaluation of the term "overcropping" which has been widely used in cereal areas. Drover (1956) analysed changes in soil nitrogen and organic carbon under four different rotations, continuous wheat, fallow-wheat, fallow-wheat-volunteer pasture and fallow-wheat-lupins-lupins at Chapman and Wongan Hills. He found that after 24 years at Chapman, the nitrogen content of soils from the continuous wheat plots was almost identical with that of soils from the four-course rotation plots which had included a total of twelve years of legumes. The nitrogen content of soils from the two-course and three-course rotation plots was considerably lower. At Wongan Hills the nitrogen content of the soils from continuous wheat plots was lower than those from the four-course rotation plots but was approximately the same as virgin soil. It was also found (Newton and Drover 1956) that at both sites there was little difference in the soil structure on the continuous wheat and four-course rotation plots whereas there had been marked deterioration on the two- and three-course rotation plots. Forster (1950) discussing similar work in other States indicates that the initial level of nitrogen in the soil may also be of importance. In low nitrogen status soils continuous cropping (without fallow) causes little change but some decrease may be expected in high nitrogen status soils.

Nevertheless, these results emphasise the importance of fallow as the principal agent causing loss of structure and decline in soil fertility in wheat belt soils. It is obvious that cereal plants in themselves do not cause soil deterioration or loss of soil nitrogen (apart from some removal of nitrogen in grain). In fact, are the cereals any different from most grasses present during a ley period in the ability of their roots to maintain soil structure? A more correct term would be over-cultivation with emphasis on the effects of fallow rather than "over-cropping". Recent work with maize (Melsted 1953) also indicates that not only can soil nitrogen be maintained under continuous cropping but, if residues are returned to the soil, if sufficient nitrogen fertilizer is applied and if excessive cultivation practices are eliminated, soil nitrogen levels can actually be raised.

Undoubtedly a decline in the amount of fallow for cereal crops is desirable. In the final analysis the two great advantages of fallow which appear difficult to overcome are moisture retention and availability of soil nitrogen. The former of these is the most difficult to surmount particularly in the drier regions of the wheat belt. Towards the wetter margins of the wheat belt moisture is not such a limiting factor. In these areas the possibility of nitrogen fertilizer being used to supplement the nitrogen supply of the crop is one which needs more investigation. Much work was carried out during the 1930's (Richardson and Fricke 1931; Richardson and Gurney 1935) with variable results from place to place and season to season. Under some conditions response to nitrogen fertilizer was quite large. At this time, however, there was much opposition to the use of nitrogen fertilizer (Callaghan and Breakwell 1937) mainly because it was thought that extensive use would lead to a perpetuation of the fallow-wheat rotation and other intensive cropping practices that were characteristic of the period. At the present time, in the cereal areas of South Australia at least, rotations are much less intensive and livestock husbandry and longer ley periods have become an integral part of almost all cereal farms. Under these conditions many of the early objections to the use of nitrogen fertilizer do not apply and the main criterion determining its use must be its profitability. In this respect the main problem appears to be the definition of soil and climatic conditions under which a profitable response can be expected.

Although the greatest scope for usage of nitrogen fertilizers appears to be towards the wetter margins of the wheat belt they may also be valuable on certain sandy soils in drier regions such as the Mallee. The total nitrogen content of these soils is very low and even nitrification over a long period is insufficient to meet the requirements of crops. Moreover establishment of legumes has often proved difficult. Recent work at Walpeup (McCann 1956) and Wanbi (Beare 1955) indicates that nitrogen fertilizer may find a place in these drier areas.

There is little doubt that in some years responses to nitrogen fertilizers are likely to be greater than others due to variable moisture and that in some years little response at all will be obtained. However, when sufficient experimental data are available it should be possible to make recommendations which, over a period of years, will be profitable to the farmer.

Use on Pastures

Pastures represent by far the largest area of land-use in Australia and the possibility of nitrogen fertilizer being used on these areas should be mentioned. As with cereals the amount being used at the present time is negligible. This is not surprising in view of the success which has been achieved with legumes and grass-legume mixtures. Nevertheless work elsewhere indicates that nitrogen fertilizer may play a useful role under certain conditions. For example, in the United States it has been found that applications of nitrogen to single species pastures such as bromegrass are very profitable. The increases obtained on these areas are large (Russell *et al.* 1954) and the pastures are less difficult to manage than grass-legume pastures. Also bloat is not the problem it is on pastures containing high percentages of legumes.

Strang (1956) discussed some aspects of the usage of nitrogen fertilizers on pastures in Australia. He came to the conclusion that nitrogen fertilizer may be applied to pastures (a) for seasonal application to mixed swards, (b) application in excess of the expected nitrogen contribution from the soil including the legume and (c) applications where the legume is absent or non-contributive. In regard to (c) particularly, nitrogen fertilizer may find a place where establishment of legumes is difficult or where suitable species are not available. Certain areas in Southern Australia may fit into this category but the greatest possibilities

appear to lie in the northern areas especially Queensland where difficulties in obtaining suitable legumes has been experienced. However, it would appear that the possibilities of large amounts of nitrogen fertilizer being used at the present time are small and that such nitrogen as is used will be for specific purposes in certain areas rather than any broad-scale usage.

Summary

Substantially increased usage of nitrogen fertilizer in Australia depends upon several factors. Probably the most important is the price of fertilizer which is very high in relation to other countries. Even at the present price there seems to be scope for increased applications on intensively cultivated crops which already use some nitrogen fertilizer. In the future increases in the area of intensively cultivated crops may also result in increased usage. Since almost 80 per cent. of the area of cultivated crops in Australia is cereals even the usage of small amounts of nitrogen fertilizer could result in greatly increased overall consumption. In this respect more investigation is needed particularly as a decrease in the amount of fallow is desirable from several aspects. With regard to pastures any substantial usage appears to be out of the question but for specialised purposes nitrogen fertilizer may be useful.

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THE BUILDING OF AN EXTENSION PROGRAMME

By JOAN TULLY

Extension work is a branch of adult education. Education changes people's attitude, knowledge and skill. If you are to bring about changes of this sort you must be able to define exactly what these desired changes are—in short you must have a programme. To set up an educational programme you need three different sorts of information, the purpose of the desired change, the subject matter concerned in the change and the methods to be used in teaching this subject matter. This paper will discuss methods of defining the purpose of an extension programme and deciding on the subject matter of the teaching programme. Extension methods are only discussed incidentally—the Murrumbidgee Irrigation Area (M.I.A) Home Service is used as a case study.

The purpose of extension work is sometimes defined as "more efficient production". For the purpose of building an extension programme this is about as useful as saying that the purpose of our education system for children is to "build good citizens". These wide general definitions of purpose are a starting point but the purpose of the teaching programme has to be defined in much greater detail before you can decide just what will be the content of the teaching programme for Grade 1.

The same holds true for the building of an extension teaching programme. An agricultural community is analogous to a class. For this purpose an agricultural community can be defined as a group of farm families carrying on similar types of agriculture under similar environmental conditions. Just as the content of a programme of work for a class is designed for a particular age group with a particular background of knowledge and experience, so must an extension programme be designed for a particular type of farming at a particular stage of development in a particular environment.

You can design a teaching programme for the ten-year-olds whose knowledge has reached a certain standard which can be used everywhere in Australia. You cannot design one teaching programme for, say, dairy farmers everywhere in Australia, because they are operating under different environmental conditions and their dairy farming is at different stages of development. In some districts pasture improvement may be needed, in others herd improvement may be lagging. Temporary ley farming may be possible in one district but not in another. The purpose of an extension programme will vary from district to district according to the major problems of the different districts at any particular time.

The content of the programmes may be the same for two districts with the same general problem, say, dairy hygiene. If the purpose of a programme in two districts were the same, say, to improve pastures, content of the programme could be different because of differences in the environment.

So, for efficient extension work there must be a programme with clearly defined purposes and content, and that programme must aim at solving some of the most pressing problems of the particular district served. Such a programme will often mean the breaking down of conven-

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tional divisions between different branches of knowledge and the integration of material from different fields for the solution of complex problems. In fact, a programme for a particular district brings the whole farm approach from the level of the individual farm to district level. Such a programme has to be evolved.

There are four main stages in this process; definition of problems, collation of data and the evolution of appropriate recommendations, the teaching process, and evaluation. For success such a programme must take account of the social, economic, physical and biological factors at work in the district. The principles can be illustrated from the M.I.A. Home Service. As part of the M.I.A. Extension Experiment, it was decided to set up a Home Service. This service was set up at the request of the Irrigation Research and Extension Committee. This Committee and the Agricultural Service realized that the attitude of the farmer's wife to the farm had a great deal to do with the policies adopted on the farm. They also realized that poor living conditions on farms had a great deal to do with the attitude of farm wives to farming. The author was the Home Service Officer.

Definition of Problems

One of the ways of defining district problems can be illustrated from the M.I.A. Home Service. Surveys are often used for this part of the process of programme building.

Home Economics teaching has traditionally centred around the teaching of cooking and sewing, subjects which have been expanded into teaching about foods and nutrition, clothing and textiles. However, on the M.I.A. there was no evidence that any section of the community was suffering seriously from malnutrition, and the majority of people were buying ready-made clothing which was serving them reasonably well. But there were many complaints about the climate and about poor housing, poor working conditions in houses, and evidence that primitive sanitation was responsible for a good deal of illness, particularly among children. A traditional programme based on the ordinary subject matter of Home Economics, cooking and sewing, would have left these important problems unsolved.

Having decided that housing was our number one problem on the M.I.A., we were in a position to state the general purpose of our Home Service. This was to "improve farm housing". But this general purpose had to be broken down still further before it could be useful for building an extension programme.

On the evidence, which could have been obtained by a survey but was, in fact, obtained from local knowledge, the aims of the Service fell under three heads:

(1) Improved farm sanitation.

(2) Improved climatic adaptation of farm housing.

(3) Improved working conditions in farm homes.

Here we had arrived at the basic subject matter of the programme, but it is still a long way from any recommendation.

One thing was clear, however, there had to be another break with the tradition of Home Extension work, which had to date, dealt exclusively with women and women's interests. This had to be a family programme aimed to interest both men and women, because of the nature of the subject matter.

As with research, the correct definition of the problem is crucial to success and one of the most difficult stages in the setting up of an extension programme. Impressions and local knowledge are likely to be based on limited contacts, and so can be misleading. A survey of the situation is a more trustworthy tool for the definition of problems. A survey also provides a datum line from which progress can be measured. It has the added

advantage of involving the people of the district in the programme from the outset and acquainting them with the general objectives of the extension work.

Collation of Data

Having defined our main problems on which the programme was to be based, we now entered the second stage of programme building—the collation of data.

As an example, let us take the collation of data for the "improved farm sanitation programme". There were many ways in which sanitation on these farms could be improved, from fly-proofing existing privies to the installation of septic tank systems. Septic tank systems had the advantage of dealing with all household sullage as well as providing good and safe toilet facilities. Water was in abundant supply, soils were reasonably permeable, but grades were flat. Therefore, septic tanks were practicable so long as they discharged near the surface. If the recommendations were to be within the financial reach of the majority, the tank and whole system must be simple, so that it was a "do it yourself" job. Plumbers were unavailable.

From these considerations, it was obvious that we needed a design for a simple septic tank which discharged near the surface, and could be constructed by the farmer himself for between £50-£100. Such a design was found in the literature. With the help of the local Shire Health Officer, a "how-to-do-it" bulletin was prepared, based on this design. In draft form this was submitted to leading Australian Sanitary Engineers for professional expert opinion on its efficiency and the details of the design. They approved it. The bulletin was published and distributed. A set of re-usable form-work for the concrete of the tank was constructed and hired out to farmers by the Shire Health Officer. This had a number of advantages; it kept the installation of the tanks under the supervision of the Health Officer; it ensured that the tanks were built to specification, and it reduced the cost of installation very considerably.

This method of collating data and getting sound recommendations from the data available has been used very successfully throughout the Home Service Programme. The Extension Officer who knows the local conditions and has defined the local problems, reads the literature on a subject that initially he knows nothing about. He discusses recommendations with experts and finally drafts recommendations. These are then submitted to a number of experts for critical review. By this method, technically sound recommendations are arrived at which are adapted to local conditions. The expert can give technically sound advice, but he cannot always adapt that advice to local conditions. This is the Extension Officer's job. It is also his job to define the local problems. By this method a realistic programme can be developed for each district with realistic recommendations.

The responsibility for developing the programme and recommendations rests with the extension officer. The expert is a resource man and the extension man will probably consult several before he can make well-integrated recommendations.

In setting up our Septic Tank Programme, we even had to get legal advice on the interpretation of the Act setting out the responsibilities of the Department of Public Health. They did not accept our simple design and their own was unsuitable for our conditions. Eventually it was discovered that they did not have jurisdiction over farms, so the programme could go on without their approval.

An extension officer has to answer questions on a great many subjects, many of which he will know little about. If he has to develop a programme which deals with fields beyond his training he can do it so long as he limits himself to information relevant to the solution of

the particular problems in which his district is interested. For example, to direct and carry through a programme to improve farm sanitation, the extension officer did not have to become a sanitary engineer. She only had to know enough about the principles behind the design of septic tanks to discuss them with sanitary engineers and to give advice on the location of tanks, and so on, to farmers.

Thus, stage two in the programme building was completed with the collation of subject matter material and the evolution of sound recommendations for local conditions. We were now in a position to start on stage three—the actual teaching programme.

The Teaching Programme

The teaching programme for the "improved farm sanitation" campaign was very simple. The press and radio were used to tell the people that a simple make-it-yourself septic tank had been designed and that the form work could be hired from the Shire Health Officer. We soon had a waiting list for the use of the forms. Groups of interested farmers were taken to see the first tanks being constructed. They were very successful. From then on the idea spread through the influence structure of the community from family to family. The form-work is still in continuous use.

More about the teaching process can be learned from the campaign to improve farm housing climatically. Before this programme reached the teaching stage the problems had been defined, data collected and recommendations suitable to the M.I.A. environment had been evolved. The environment included the climate, the type of farm house and financial resources of the average farmer.

The home improvement programme was breaking new ground. People had come to accept their homes as they were and had long ago come to the conclusion that nothing could be done about them. Their homes were "good enough" in their opinion. Before any changes would take place, this attitude would have to change.

The teaching part of the Home Service programme was inaugurated with a big Housing Demonstration. This was designed to show that old houses could be improved climatically for relatively little money, new houses could be better designed for the climate, and kitchen work areas could be much better designed for convenient working. It was designed to highlight some of the problems and show the solutions. This Demonstration was supported by press and radio campaigns and received Commonwealth-wide publicity. The Commonwealth Experimental Building Station (C.E.B.S.), the experts on design for climate, co-operated in this Demonstration very fully. They supplied the subject matter, models and a demonstrator, but the local officer did all the organizing.

This Demonstration set the ball rolling. Requests for information, advice and home visits began to pour in. Groups and organizations asked for lectures on the subjects. A film "My Handy Kitchen", was made locally and used extensively for these lectures. The film was supported by slides of the main features shown on the film. These were used as a basis for discussion. A special bulletin, "How to Improve Your Kitchen", was produced and distributed at these meetings. The meetings led to many more requests for detailed plans for individual kitchens.

It soon became obvious, however, that we needed a practical demonstration locally that the principles of design for the climate would, in fact, work locally. We needed a permanent local demonstration that would always be available for use with individuals. If a farmer adopts a new practice and allows the extension man to bring farmers on to his property to show them how the idea works, this becomes a demonstration farm for that practice. A demonstration house incorporating the principles laid down by C.E.B.S. was needed. Eventually, with the co-operation of C.E.B.S., such a house

was built in pisé. Records were kept of its performance and compared with the performance of an adjacent old style house of timber and fibro. The records proved the point that correct design and use of insulating materials would reduce maximum temperatures by more than 10°F. The house was used continuously as a demonstration from its completion in 1951 till the termination of the Home Service in 1956.

During the construction of the demonstration house, a film, "Homes for the Inland", was made. This film, with supporting slides, was again used extensively for lectures to groups and organizations. These stimulated many enquiries. Regular broadcasts and press releases instituted at this time added their quota to the enquiries coming in.

The main difficulty with the Demonstration house was that it was built of pisé. This caught popular imagination, and the details of design tended to be overlooked. Furthermore, a reliable pisé builder could not be found. Requests for plans for farm homes designed for the climate began to pour in. Had we had an architect available who would have drawn plans of farm homes incorporating the principles of design for climate elucidated by C.E.B.S. we could have started a small revolution in the design of farm houses. This part of the extension campaign failed for the lack of the right expert at the right time.

The Housing Conference was an attempt to interest architects, financial institutions, government departments, builders and allied trades in the problem of the design of farm houses for the inland climate. Recommendations for the design of such houses were accepted, but plans have not been forthcoming. The demand is there, but remains unsatisfied.

Evaluation

The fourth stage in any extension programme must be an evaluation of the progress made as a result of the extension programme carried out. An evaluation is usually made by a survey which assesses the new situation which has been created by the extension campaign. At the same time it reveals where further progress can be made and provides the data for defining further problems which can be tackled in future extension programmes.

Thus, extension work is seen as an orderly process which moves a farming community from the recognition and solution of one set of problems to the recognition and solution of the next. It is not entirely a haphazard affair based on questions from individuals about individual problems. It is a community affair with the majority of farmers moving from one stage of development to the next.

The Extension Process can be thought of as a cyclic progression from one extension programme to the next. It can be illustrated diagrammatically by a spiral.

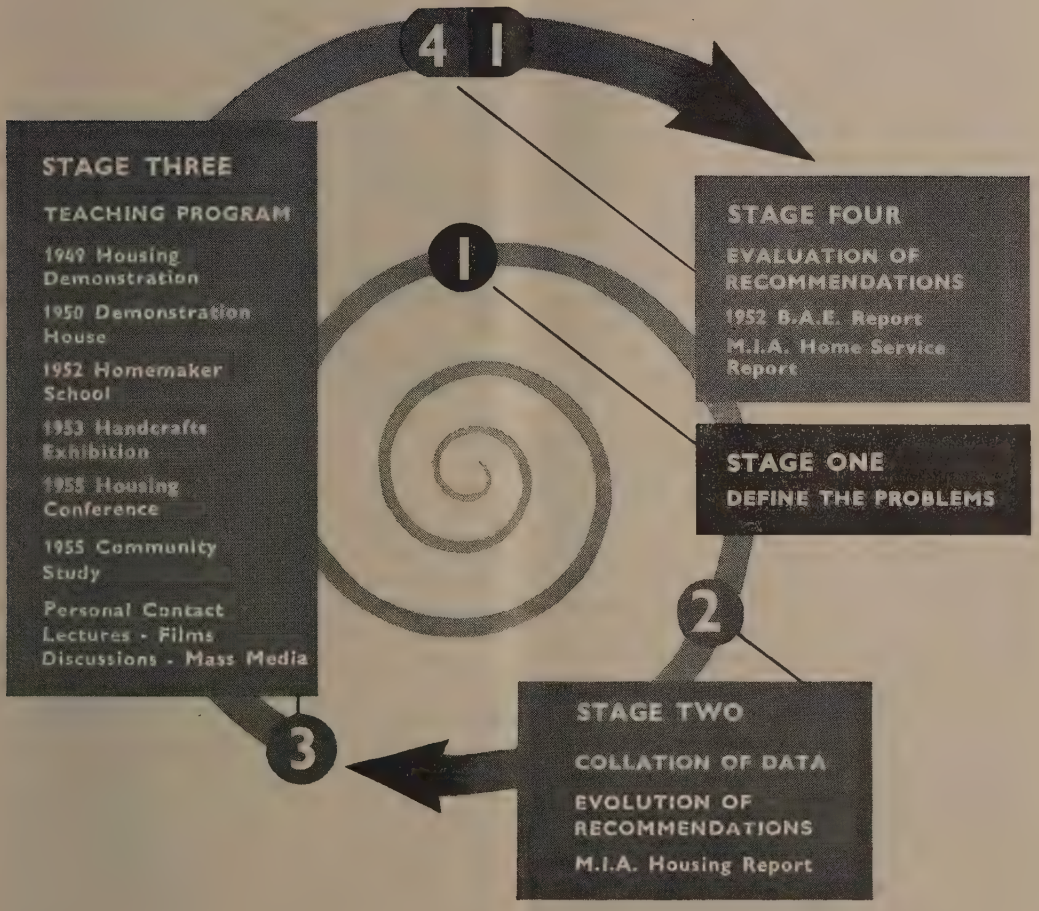
Figure 1 shows one cycle of the spiral almost completed by the M.I.A. Home Service. The final evaluation survey was not carried out.

However, in 1952, when the Home Service had only been in operation three years, the Bureau of Agricultural Economics made an evaluation survey of the "Agricultural Extension Services on the M.I.A." of which the Home Service was a part. This survey revealed one major defect in the Home Service. We were not serving the Italian farming community which constituted something like a third of our farming population. This illustrates the sort of purpose that an evaluation survey can serve in extension work. You then have facts on which to base policy and not just opinion. Facts are a much more satisfactory basis for the spending of public money than opinions.

The Importance of the Social Structure

The fact that we were not contacting the Italian community revealed by the B.A.E. Survey brings out another fact of great importance in the operation of an extension programme. This is the im-

THE PROCESS OF PROGRAM DEVELOPMENT



The Process of Program Development can be represented as a spiral which symbolises both its cyclic and dynamic qualities.

Figure 1

portance of the social structure within a farming district. In effect we were dealing with two quite separate communities, the Australian and the Italian, and there was relatively little communication between the two. This is probably rather an extreme case, but similar cleavages occur in most farming districts. They may have a geographical base. The Griffith end of the M.I.A. formed a separate community from the farmers at the Leeton end. The cleavage may be based on status. For instance, in some districts there are old properties which are very large and smaller properties belonging to newcomers to the district, perhaps soldier settlers. Cleavages may have a religious base, and many other factors may operate in the same way. Unless these cleavages are recognised and special measures are taken to contact all communities within the district, sections of the farmers are likely to remain backward. Communication does not take place at all freely across the barriers set up by these cleavages.

On the M.I.A. the Italian community felt itself to be quite separate from the Australian community. The Australians ran everything, the Shire, the hospital, the co-operatives, and so on. The Italians saw all community services, including the extension service as being run by Australians and for Australians. Their attitude was "this is your country; you run it. We don't want to interfere. We are happy so long as we are allowed to have our farms and make a living." The unequal distribution of community responsibility, participation and power probably occurs in other districts as well as on the M.I.A. Such a situation leads the socially insulated community to be diffident about taking part in extension programmes or asking for advice. It is a problem of access. This indicates the way in which the social structure of communities can affect the efficiency of an extension programme.

On the M.I.A., steps were taken to bring Italian farmers into extension activity. There was, at this time, a very active extension organization based on neighbourhood groups on the M.I.A.—Extension Groups. The membership was almost exclusively Australian. These groups were persuaded that they should encourage Italian farmers to join them. In many cases they persuaded a few Italians to come to meetings and then put one or two of these Italians on their committees. The job of these Italian committee-men was to persuade their fellow countrymen to come to extension group meetings and take part in extension activities.

It was found that many Italian farmers were exceedingly diffident about expressing themselves at meetings or taking any responsibility for group work. This was partly overcome by their participation in extension group work, but as a group they needed more help and training than they got by these means. To fill this need and to provide a further channel for communication with the Italian community, a Continental Music Club was started. It provided an organization, largely Italian in membership, through which contact could be made with the Italian community. It was felt to be unwise to start Italian Extension Groups, as this would have perpetuated the split between the two communities. Music was something characteristic of the Italian culture and yet not exclusive to it. It was a peripheral and neutral interest of both groups. This is another illustration of how an appreciation of the social and cultural factors in a situation can be used to further extension aims. The aim has been to train the Italian community in participation and leadership so that they can play their part in extension activity and in the community generally.

Another good example of the importance of an appreciation of the cultural values of a group to efficient extension comes from the Home Service. It was necessary to contact large numbers of Italian farm women, to gain their confidence and to show them that they, too, belonged and were to be served along

with the Australian community. As the majority of these women spoke no English this was a rather tall order. An appreciation of one of their cultural values made it possible. In the Italian culture, a girl's "glory box" is of great social importance. Much of their exquisite needlework and lacemaking is done for "the glory box". Appreciation of this lovely work could be expressed without a common language. An Exhibition of Continental Handicrafts was arranged. Psychologically, this had a great advantage in that it allowed the unappreciated group to contribute something to the rest of the community which was appreciated by them. It gave the whole Italian community a great boost and put them in the frame of mind to participate more fully in community affairs, including extension activities.

Integration of Extension Staff into the Community

To make an extension programme a really vital part of the community life, it should be woven into the very fabric of that life. The Department of Agriculture and its officers should not be regarded by the people as just another government department doing a job like the railways or the post office. Department of Agriculture officers have to become people who belong to the community. To do this they have to become members of local organizations and work with the people on their own affairs.

The spread of interests among members of staff of the M.I.A. Agricultural Service was surprising. There was a Shire Councillor, President of the Show Society, President of the Junior Farmers' Advisory Committee, President and Secretary of the Good Neighbour Council, Member of the Public Library Committee, Hospital Board, Arts Council, Parents and Citizens' Association, Baby Health Centre, Scouts, Dramatic Society, Discussion Groups, Continental Music Club, Secretary of a Medical Benefits Society, leading members of the Country Party and Labour Party, Rotary Club, Masonic Lodge, Churches, Country Women's Association, and so on. There was almost no section of that community from whom we could not seek co-operation for our extension programme, not as officers of the Department of Agriculture but as friends and fellow workers.

The importance to successful extension work of these types of contact within a community can hardly be over-estimated.

A warning note must be sounded here. It is important that an extension officer is not "captured" by some special interest group in the community. If he is then the Extension Service may be seen as serving only this group. If there are a number of officers concerned and they spread their interest through different sections of the community the "capture" of an individual officer by one section of the community does not jeopardise the service so much.

Conclusion

For efficient and successful extension work a programme designed to tackle the most pressing local problems on a whole farm rather than on a subject matter basis must be built up for each district and each major type of farming in each district.

The building of such a programme is a process which follows a logical pattern.

First the problems must be defined and those selected which are most frequent and the most basic and urgent in the district.

Data must be collected from all sources. Problems are no respecters of academic divisions. Practical recommendations which are technically sound but also consider the resources of the majority of farmers in the district must be evolved. The farmers' resources include land, labour, stock and machinery as well as finance.

A teaching programme must be planned and carried through using all the methods in the extension armoury as and where they are appropriate. The teaching pro-

gramme must aim at the general recognition of the problems as defined and of the recommendations as practical solutions to these local problems.

The teaching programme must take cognizance of social and cultural patterns in the community which may provide barriers to the flow of ideas and the adoption of recommendations.

When the teaching programme has been in operation for a reasonable period an evaluation survey should be made. Such a survey finds out in what directions and to what extent the programme has succeeded in getting the recommendations adopted and where it has failed. It should also be able to find out why the the programme has failed. At the same time further urgent local problems are defined and the process starts again from a new point in the agricultural development of the district. Only thus can a farming district be guided smoothly and at a reasonable pace along the path of progress using the latest scientific information to increase its agricultural and social efficiency.

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LETTER TO THE EDITOR

An Open Letter to my Colleagues

Dear Sir,

On your desk, as on mine, there will be a large stack of technical journals, bulletins and books which it is your task to read, understand and to add to your knowledge. Like me, you will have found it increasingly difficult to keep up with this never-ceasing flow of literature which is published by our fellow scientists. And if further you are of a critical turn of mind then you will also know that some of the published matter is useless dross, much of it is written in bad English—cumbersome phrases, scientific jargon, long winding paragraphs—and that most of it could have been shortened without loss to anyone.

You may take heart that our profession is not the only one to suffer from this hardening of the literary arteries, as the problem is recognized by technical librarians everywhere who have to handle, file and index this daily increasing result of scientific verbosity.

Apart from the legal profession, where confused verbiage is a recognized weapon, there is today no profession which writes quite so much and cares quite so little for its readers as the scientific one. Partly this stems from a mistaken belief that a scientist is judged by the volume of his printed words, much as a cow is judged by the volume of its milk production. Partly it stems from a belief that our articles should be carefully documented semi-legal records rather than means for communicating ideas. And partly we tend to think that unless we are sufficiently technical we may be adjudged vulgar dilettantes.

Now let us try to keep this journal, at least, free of the unnecessary, the uninteresting, the purely erudite. Let its reviews serve to bridge the gap between the technical article of the specialist, whose jargon we have forgotten since we left the university, and the extension digests. Let the technical articles be interesting to at least some readers and intelligible to most. For quite apart from the sheer waste of writing words which few can comprehend, you and I have to pay for the privilege of having them published in this ever-lengthening journal. And why should we pay for something we do not or can not read?

So may I ask you a favour? When next you sit down to write a technical article, would you please ask yourself: Is it really necessary? Can it be written more clearly and with less words? Will it interest anybody?

I will try and do the same.

Yours, etc.,

PAUL BAXTER.

Dept. of Agriculture,
Victoria.
May 2, 1957.

HOST-PATHOGEN RELATIONS IN PLANTS

By N. H. WHITE

The results of research into the relationships between pathogens and their host plants during the last decade or so makes it possible to review the phenomena in new perspective and at the same time review the relationships of all the pathogens (fungi, bacteria, nematodes, and viruses) rather than one particular group. A proper understanding of host-pathogen relationships establishes an objective approach to both breeding and selection for disease resistance in plants as well as to the actions of chemotherapeutants or systemic fungicides.

The relationships between pathogens and their plant hosts are concerned with the impact of the genetic systems of both pathogen and plant host in any given environment. Relationships begin when inoculum of the pathogen is brought into contact with or introduced into a plant; and the inoculum of all kinds of pathogens and all varieties of plants should be considered.

The difficulties of interpretation and usage of terminology associated with host-pathogen relations are well known. This is largely due to the fact that the terms were introduced before the phenomena were properly understood. Gaümann (1950) attempted to clarify the position but has failed in some measure to achieve this through drawing on the terminology used in medical science which seems to be more confused than our own. Some of the difficulty has arisen in not distinguishing between *"resistance to infection"* and *"resistance to disease"*; and also *inoculation* and *infection*. The usage adopted in this article is that a plant is *inoculated* when the pathogen first contacts it, and becomes *infected* when the plant tissue begins to respond to the presence of the invading pathogen.

Infection is defined as that phase which extends from germination of the inoculum of the pathogen till it enters into some form of parasitic relationship with its host. The relationship might not be a good one from the point of view of either pathogen or host, but there is some attempt to establish a relationship.

Plants in relation to inoculum of pathogens (and other micro-organisms) are either (i) *Non-reactive* or (ii) *Reactive*.

Non-Reactive Plants

These are the "wrong hosts". In these the relationship between pathogen and plant will vary from one in which both are entirely without significance to each other, to one in which the pathogen is without significance to the plant. These plants do not respond or react in any way to the presence of the inoculum, and are not susceptible to infection. The non-susceptibility of these plants is due to their possession of mechanical or chemical barriers to infection. Their immunity from infection is a passive one in that they possess these characters irrespective of the presence of the inoculum. This is the Axeny of Gaümann's terminology. Mechanical barriers may take the form of thickness of the cuticle, or stomatal structure and function. There are two kinds of chemical barriers to infection. The first is host antibiosis to the inoculum of the pathogen, found in brown and pigmented onions whose scales contain protocatechuic acid which inhibits the germination of conidia of *Colletotrichum circinans*, the cause of onion smudge disease in white scaled onions. Other examples of this type of host antibiosis have been considered elsewhere (White 1956). The second kind of

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chemical barrier is the constitutional unsuitability of the plant tissue as a substrate for the development of the pathogen as for example when active virus particles are introduced into cells of immune plants where either suitable sites for virus multiplication are lacking or the cells are deficient in the virus-making mechanism for that particular virus (Best 1956).

Reactive Plants

These plants are all susceptible to some degree of infection and they react or respond in some way to the pathogen, but they only react when the pathogen is present. The form and intensity of the response will determine the success or otherwise of the establishment of a relationship between the host plant and its pathogen. The relationship may be one of symbiosis, as found in certain mycorrhizas or one of extreme antibiosis of one or other or both of the partners in the relationship. Plants in which the host reaction to infection prevents successful colonisation by the pathogen are resistant to the disease caused by that pathogen and as there are varying degrees of host response to infection so there are varying degrees of resistance to the disease. Plants which permit unhindered colonisation and development of the pathogen are completely susceptible to the disease caused by that pathogen. They behave as passive substrates for these pathogens, and in these there is usually a maximum expression of the disease. Between these two extremes there are plants whose reactions are less violent than either, which endure infection and colonisation by the pathogen without showing severe disease symptoms. These plants are tolerant hosts, as for example certain hosts infected with viruses, smut and rust fungi.

Infection of plants results in the alteration of host cell physiology which is usually expressed in necrogenic or histogenic reactions of the host tissue. Necrogenic reactions result from the collapse and death of host cells because they are physiologically sensitive to the presence of the pathogen or its metabolites. Histogenic reactions are the result of disturbances in cell formation and differentiation through the presence of the pathogen or its metabolites which is expressed in hyperplasia or hypertrophy or abnormal cell and tissue components.

Necrogenic Host Reactions

The intensity and rapidity of the necrogenic reactions of host plant tissue depend on the sensitivity of host cells to the pathogen, or its metabolites. In hypersensitive hosts infection rapidly evokes necrogenic changes. For necrotrophic pathogens, which typically live on non-living substrate provided by the dead host tissue, this favours the establishment of parasitic relations. For biotrophic pathogens, that live on the living substance of the host, this prevents the establishment of a stable parasitic relationship. In discussing the significance of necrogenesis in host pathogen relations it is therefore necessary to consider these two biological groups of pathogens separately.

(*a*) *Necrotrophs*

These are parasitic in attack and must kill their host tissue in advance of penetration in order to colonise the host. This they succeed in doing in hosts whose cells are sensitive to their metabolites which results in soft and dry rots of plant parts. Most of the bacterial plant pathogens and many fungi belonging to the *Pythiaceae*, Ascomycetes and fungi imperfecti are necrotrophs. The main effect of their metabolites on the cells of susceptible hosts is to destroy cell permeability which allows the escape of substrate material from the host cells. The nature and mechanism of action of these metabolites awaits further investigation but in soft rots these necrogenic changes are associated with pectolytic enzyme activity, whereas in dry rots there is no evidence of pectolytic activity (Brown 1955). In hosts whose cells are not sensitive to the fungal metabolites the destructive permeability changes do not take place, and there is no necrogenesis. These tissues are not colonised by the necrotrophs and the plants are resistant to the disease. How-

ever tissues of resistant hosts may be readily colonised by necrotrophs if their permeability is artificially destroyed. *Botrytis cinerea* and *Monilinia fructicola* for example will not colonise living potato tuber or living bean pod tissue but when the permeability of these tissues is first destroyed by exposing them to chloroform vapour both fungi will readily colonise the dead tuber and pod tissue. Some host tissues are not colonised by necrotrophs apparently because there is little or no escape of substrate material from the cells to provide the germ tubes of the necrotroph with an external source of energy which appears necessary for the production of permeability destroying metabolites. These hosts may be colonised by necrotrophs if an external source of substrate material is supplied to the germules of the necrotroph. *B. cinerea* and *M. fructicola* for example will colonise green bean pods if dilute turnip juice extract or potato dextrose agar is added with the spore inoculum of these fungi, and also when they are wound inoculated on to the pods. (The injured cells provide the needed substrate material.) However some plant tissues are not sensitive to the metabolites even when the inoculum is provided with a food base. Living potato tuber tissue is not colonised by *B. cinerea* and *M. fructicola* when the inoculum is supplied with a food base. The immunity of living potato tuber tissue from infection by these two fungi appears to be due to hyposensitivity of the tissue rather than to axeny because the fungi grow well on dead tuber tissue and no antagonistic substance to these fungi has been demonstrated in tuber tissue.

In latent infections associated with ripe rots of fruit, the green and immature fruits are infected with certain necrotrophs. Following infection the pathogen remains dormant in the sub-cuticular region of the immature host (Simmonds 1941), until the fruit ripens or becomes senescent when the necrotroph freely colonises the tissue. What has already been stated here about necrotrophs and host tissue relationships is pertinent to this phenomenon and it is apparent that the phenomenon can be explained on the basis of relative sensitivity of immature and mature host tissues. These necrotrophs including *M. fructicola* develop freely in chloroform killed immature host tissue, and some of them will colonise immature fruits when provided with a food base (i.e. by wound inoculation and by adding nutrient to the inoculum), e.g. *M. fructicola* on stone fruit. Others though developing luxuriantly on the killed immature tissues of their host will not colonise them in the living state when supplied with a food base, or if they do, only to a limited extent (e.g. *Gloeosporium musarum* on banana). These resemble the behaviour of *B. cinerea* and *M. fructicola* on potato tuber tissue. An investigation of the phenomenon of latent infection from this point of view is considered elsewhere in more detail (White and Griffin, 1957).

The vascular wilt pathogens, both fungi and bacteria, are necrotrophs, and in their susceptible hosts are confined to the vascular tissue. They are restricted to this tissue because the surrounding tissue is not sensitive to the metabolites produced by them. Only after the root or stem tissue is dead or moribund will the necrotroph grow out of the vascular elements into the surrounding tissue. These necrotrophs must gain entry to the vascular tissue in order to colonise their host. They can invade only the vulnerable undifferentiated tissue near the root tip or through wounds in that region (Garrett 1955). Once they reach the xylem elements the toxic metabolites kill the xylem parenchyma in advance producing the typical vascular browning. In resistant hosts the necrotroph is either unable to penetrate to the vascular elements or it enters the vascular elements but the parenchyma is not sensitive to its metabolites.

(*b*) *Biotrophs*

These have specialised host cell relations being either inter- or intra-cellular parasites and can only develop in their host so long as their host's cells remain alive. They are obligately parasitic fungi (rusts, downy and powdery mildew fungi), plant

viruses, some plant nematodes, and some facultative saprophytic fungi (*Phytophthora* species, and *Venturia inaequalis*). Biotrophs usually provide their propagales (spores or eggs) with sufficient food reserve for the germules to feed on until they establish host relationships. They must therefore establish a parasitic relationship with their host as soon as invasion takes place. For successful colonisation it is essential that their host's cells remain alive, and in completely susceptible or congenial hosts infection does not result in the death of host cells and the parasitic relationship is soon established. In some relationships of certain biotrophs (e.g. *Phytophthora infestans* causing late blight of potato, the downy mildews, and *V. inaequalis* causing black spot of apple) and certain viruses causing local lesions and systemic necrosis, their parasitism on congenial hosts ultimately leads to the death of host tissue, but it does not occur until after the biotroph has been able to reproduce itself or invade new areas of living host tissue.

Some plants are hypersensitive to these biotrophs or their metabolites, and in these plants invasion is followed by a necrogenic host reaction. The rapidity and intensity of the necrogenic response to infection by a biotroph varies with the pathogen host combination—the more sensitive the host cells the more rapid their collapse or the more toxin produced the more rapid the reaction. This hypersensitive necrogenic reaction is a defence reaction which Gaümann has defined as hyperergic necrogenous reactions, and renders these plants uncongenial as hosts and therefore resistant to the diseases caused by the biotrophs. Thus plants in which infection with a virus results in rapid development of local necrotic lesions in the inoculated tissue are resistant to the disease caused by that virus. (There are of course virus-host plant relationships in which local lesion formation is followed by systemic invasion). Wheat varieties in which infection with black stem rust results in tissue necrosis around the infection court are resistant to black stem rust disease. In cereals resistant to powdery mildew disease, infection is followed by a necrogenic reaction of the infected cell or the mesophyll beneath the infection court (White and Baker 1954, Hirata 1956). Potato varieties which are hypersensitive to *Phytophthora infestans* when infected with this biotroph give a necrogenic reaction much more rapidly than normally occurs on congenial hosts so that the fungus is unable to invade new areas and sporulate before the tissue collapses (Müller 1940). A similar sequence of events occurs in plants resistant to downy mildew diseases.

In both congenial and uncongenial hosts biotrophs exhibit antibiosis towards their host cells which results in a disturbed host cell metabolism in and around the infection court following infection as revealed by studies on cytochemical changes (Humphrey and Dufrenoy 1944), respiration (Allen and Goddard 1938), permeability changes (Thatcher 1943) and accumulation of substrate material (Shaw and Samborski 1956).

The antibiosis is induced through the production of a phytopathogenic toxin by the biotroph and/or the infected host cells which Dimond and Waggoner (1953) have described as a vivotoxin. Millerd and Scott (1955) have demonstrated such a toxin in barley leaf tissue infected with *Erysiphe graminis*, and Swaebly (1956) has proved that a toxin is produced by germinating uredospores of *Puccinia graminis* var. *tritici*. Though little work has been done on these toxins, it seems that they may be antimetabolites which compete with the host cell metabolism or they may cause an increase in host cell metabolism through excessive loss of vital substrate material from the host's cells. Work being carried out at Sydney University indicates that for the biotroph *Erysiphe graminis*, the toxin is a respiratory factor which stimulates host cell respiration. (Millerd and Scott 1956). Shaw and Samborski (1956) from their investigations suggest that the stimulation of respiration of infected tissues is due to the increased metabolic activity resulting from the

accumulation of substrate material in the infection court. Viruses differ from other biotrophs in that the provirus itself would be the antimetabolite in competing with normal cell protein synthesis, and in this way exhibit antibiosis to their host cells.

In hypersensitive hosts the metabolic disturbance is apparently more rapid and intense than in hyposensitive or congenial hosts. The collapse of the tissue in hypersensitive resistant hosts is considered by most workers to interfere with the nutrition of the biotroph. Where the pathogen is intracellular (e.g. Viruses and archimycete fungi) this must be so, but where the pathogen is intercellular with or without haustoria, this is not necessarily the reason for the failure of the biotroph to colonise the tissue. In fact there is a weight of evidence against the validity of this explanation.

In many hypersensitive hosts infection results in cell collapse in groups around or beneath the infection court, but rarely completely surrounding the infection court. In these hosts there is still a large proportion of the cells remaining alive. In powdery mildew of cereals, the spongy mesophyll cells beneath the infection court are the ones that collapse, (White and Baker 1954, Hirata 1956), and in some types of necrotic host reactions to rust infection all the cells around the infection do not collapse or if they do, it is not till after the rust fungus has developed to some extent beyond the infection court. It seems more logical to postulate the release of substances from the collapsed cells which are antagonistic to the biotroph. Investigations on powdery mildew of barley at Sydney University to be reported elsewhere (Scott, White and Millerd 1957), reveal that the arrested development of *Erysiphe graminis* on resistant varieties of barley giving mesophyll collapse is due to the production of a phenol which inhibits the growth of that fungus. Though this phenol is present in all normal barley leaves, it is produced in much greater quantities in infected resistant varieties giving the necrogenic hypersensitive reaction. In barley mildew there is then a two way action or reciprocal antibiosis, on resistant varieties. The pathogen or invaded cell produces a toxic agent which leads to the collapse of the hypersensitive mesophyll cells which, in turn, release a phenol which inhibits further development of the pathogen. How widespread this phenomenon may be is not known, but it is not claimed that it would be the universal explanation for the inhibited development of the biotroph on resistant hosts. It does, however, lend support to the view that impaired nutrition of the biotroph through collapse of the host cells cannot be the universal explanation for failure of biotrophs on resistant hosts as is generally assumed. In support of the hypothesis that the tissue killed by the pathogen produces a toxic inhibitor of fungal growth it is interesting to quote the following examples. *Phytophthora infestans* causing late blight of potatoes cannot be isolated from the tissue killed by this pathogen, though it can be grown on artificial media, and a toxin has been found in infected tissue which inhibits the germination of sporangia of *P. infestans*. Skoropad and Arny (1956) found that the necrotroph *Helminthosporium gramineum* causing barley stripe failed to develop and the mycelium died in necrotic tissue formed in resistant varieties of barley following infection by this fungus.

It is apparent from what has been said about necrotorophs and biotrophs that necrogenic host reactions resulting from host sensitivity to the pathogen or its metabolites have opposite values for these two biological groups of pathogens. These relationships are shown in Figure 1 where it is seen that increasing host sensitivity gives greater susceptibility to necrotrophs and a corresponding degree of resistance to biotrophs. The exception to this generalisation occurs when necrotrophs induce the characteristic necrogenesis in certain hosts, their growth is inhibited by an antibiotic substance released from the dead cells as in *H. gramineum* on resistant varieties of barley. This reaction is similar to that which occurs when biotrophs

induce necrogenesis in their resistant hosts.

Histogenic Host Reactions

The response of some reactive plants to infection is expressed in histogenic changes which are of two main types. One is a defence reaction attempting to seal off the invading pathogen or prevent extensive colonisation of the tissues, and the other is the formation of histoid or organoid galls permitting full development of the pathogen.

(*a*) *Histogenic Defence Reactions*

These are hyperergic reactions occurring in hypersensitive plants and may be induced by both necrotrophs and biotrophs. In many plants these histogenic reactions confer resistance on them. They vary from a thickening of the cell wall at the point of entry of the pathogen to the formation of callose sheaths around haustoria and lignitubers around invading hyphae. Many necrotrophs including saprophytes were shown by Young (1926) to invade the coleoptile of wheat but were prevented from further development by the formation of lignitubers or callose around the invading hyphae. Some pathogens succeed in colonising their host in spite of lignituber formation, e.g. *Ophiobolus graminis* in wheat roots.

Wound cork formation is a natural healing process in plants in response to injury due to traumatic, chemical, and pathogenic causes. It might be considered as another type of histogenic defence reaction and therefore as a mechanism of resistance to disease because it limits the extent of colonisation of plant tissues by the pathogens. However, care must be observed not to misinterpret the significance of this cork barrier for as Brown (1955) has pointed out they may not be of any greater significance than a monument on a battle field merely marking the place where an issue was decided. Such wound cork barriers are found in the roots of varieties of plants resistant to vascular wilt fungi, and in shot hole of stone fruit and *Cercospora* leaf spot diseases where wound cork is formed at the margins of the lesions (Cunningham 1928). Though these localised lesions may be due to the cork barriers, there are many diseases caused by fungi in which there are local lesions that do not have margins of wound cork (e.g. Septoria leaf spots).

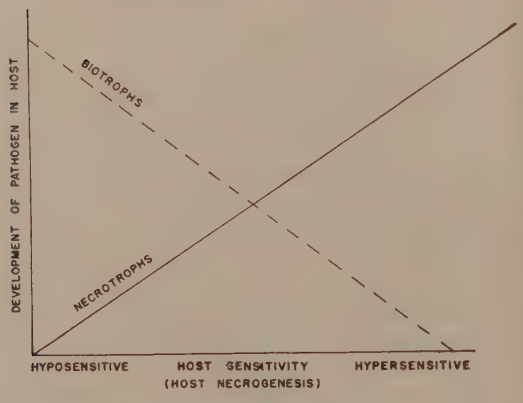

Figure 1.
The relationships of necrotrophs and biotrophs to host necrogenesis.

(*b*) *Histoid Galls*

These are the symptomatic expression of the successful colonisation of congenial hosts by certain biotrophs. Biotrophs induce hyperplasia and hypertrophy of the tissue in susceptible hosts, and it appears that for many biotrophs these histogenic responses are obligatory for successful colonisation. If biotrophs fail to induce these responses they do not develop in the tissue and the plant is resistant to the disease. Thus if larvae of the root knot nematode *Meloidogyne* spp. fail to stimulate giant cell formation when they have penetrated to the cambium they do not survive or complete their development in the plant. *Plasmodiophora brassicae* can only induce histogenic changes in roots of members of the family *Cruciferae*. Furthermore many of the gall forming pathogens can establish a parasitic relationship only in young tissues of their host, so they invade leaf, shoot and root primordia and meristems. For example, *Taphrina deformans* infects and colonises only young leaves soon after bud burst, but does not colonise mature leaves apparently because it fails to stimulate hyperplasia.

Gall formation is not obligatory for successful colonisation in virus diseases, and may not be necessary for some other gall-forming biotrophs, e.g. Crown gall bacteria.

Conclusion

Two basic phenomena appear to be involved in the relationships between different pathogens and their reactive host plants. One is concerned with host sensitivity and the other is concerned with the nature of the antibiosis between the two partners. The term sensitivity was first used in the consideration of host pathogen relationships when Stakman (1915) used the term hypersensitivity to describe the rapid reaction of tissue of resistant hosts when infected with *Puccinia graminis*. Many writers consider hypersensitivity as an expression of extreme susceptibility so that resistant plants are more susceptible than susceptible ones. Some writers disagree with this concept (Yarwood 1956) mainly because writers supporting the hypothesis have confined hypersensitivity to host reactions of biotrophs. It is clear from what has been said in this article that hypersensitivity is associated with both necrotrophs and biotrophs, and appears to be universal in pathogen host relationships. In establishing sources of host resistance, sensitivity should be used as a basis. For necrotrophs decreasing sensitivity gives resistance, whereas for biotrophs the reverse holds in that hypersensitivity gives resistance through hyperergic defence reactions. However, for biotrophs causing histoid galls the situation is different in that hyposensitivity would lead to resistance because of the absence of response to the pathogen, and over stimulation in hypersensitive plants would give the hyperergic defence reaction. Host sensitivity may be altered by environmental conditions, e.g. light and temperature, and there is the possibility that chemotherapeutants may be found which will alter the sensitivity of the host to give it resistance to the disease caused by a specific pathogen. Susceptible varieties of barley to powdery mildew may be made resistant by adding to the leaves small quantities of the toxic respiratory agent found in mildew infected resistant barley varieties, which makes them hypersensitive to the presence of *Erysiphe graminis* (Scott, White and Millerd 1957). Holmes (1955) has shown that absorption of thiouracil by *Nicotiana* hybrids possessing the NN hypersensitivity factor to tobacco mosaic virus have their sensitivity to the virus increased so that systemic spread of the virus does not occur.

It appears that some of the resistance due to host necrogenesis results from the production of substances in necrotic tissue that are antibiotic to the pathogen. Although this probably occurs more widely with biotrophs it can also occur with necrotrophs, as was shown by Skoropad and Arny (1956). This ability to produce antibiotic substances in tissue necrosis is another factor to be sought in selecting and breeding plants for resistance to disease. Again it is possible that the same results may be achieved by discovering a chemotherapeutant that will act systemically in the plant.

Most of the work with chemotherapeutants so far has been concerned with finding substances that will be taken up systemically by plants which then either act as an antibiotic to the pathogen in its unchanged state, or give rise to an antibiotic substance that is closely related to it chemically, or give rise to an antibiotic through changing the plant's metabolism. It is suggested that in addition to these the possibility of finding a substance that will alter the sensitivity of the plant and/or that will induce host plant cells when infected to form an antibiotic substance as occurs naturally in some pathogen-host relationships, should also be considered.

In any consideration of host-pathogen relationships in plants, it is interesting to speculate on the origin of the parasitic relationships. It is generally conceded that parasitism by any group of organisms is a specialised evolutionary side line of recent development from unspecialised heterotrophic forms. While this is probably true for most necrotrophic

pathogens, the situation may be quite different for biotrophic pathogens. Parasitism should be regarded as an "ecological niche", that is not readily "invaded" or abandoned by any series of organisms, and the obligate nature of the parasitism of biotrophs in which there is the need for keeping the host cells alive does not seem to be readily acquired. Since it is unlikely that saprophytes could invade plant tissues without killing them, it is reasonable to suppose that the delicate balance between biotrophic pathogens and their host plants is most likely to develop when both are in a genetically plastic condition, as they would be during their evolutionary phases rather than when they approach a climax of evolution. Saville (1955) has advanced strong arguments to support the view that biotrophic fungi appear to have been derived through a parasitic evolutionary series that antidate any land flora, and that it is more probable that the first successful fungi were strictly parasitic, and that heterotrophic forms were repeatedly derived from them since the acquisition of enzymes needed for such a habit is a less difficult undertaking than acquiring the delicate adjustment demanded of biotrophic pathogens. It seems then, that the pathogenic relationships of necrotrophs may have arisen from saprophytic organisms as a result of multiple invasion of the "ecological niche" of parasitism, and an example of this is seen in the concept put forward by Garrett (1955) that the root-inhabiting fungi have evolved from soil inhabiting fungi with high competitive saprophytic ability into a group of ecologically obligate parasites. However, the pathogenic relationships of biotrophs appear to be ancestral in that the biotrophs may have been derived from ancestors with a high degree of parasitism rather than from saprophytes. Thus Saville (1955) claims that the ancestral Basidiomycetes were parasitic and from them one branch gave rise to the rusts with increasingly obligate parasitic host relationships, and other branches gave rise to the remaining orders, most of them now saprophytic in habit.

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APPOINTMENTS AVAILABLE — *See also pages 143, 148, 167, 179, vii.*

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Applicants should have a University Honours degree in Agricultural Science or Science, with Biology as a major subject, or a degree in Veterinary Science, or equivalent qualifications, preferably with research experience. Applicants should be willing to spend extended periods in the bush and should preferably have experience of the pastoral country, with some ability as regards vehicle maintenance.

Dependent upon qualifications and experience commencing salary will be determined within the salary range of Research Officer, £1,287-£1,912 per annum.

The appointment will be conditional upon a satisfactory medical examination and the appointee may be asked to serve an initial probationary period of up to twelve months before being confirmed in his appointment as an officer of the Organization. If so confirmed he will be required to contribute to, and eligible to receive benefits from, either the Commonwealth Superannuation Fund or the Commonwealth Provident Account.

Applications, quoting reference number 560/46 and stating full name, place, date and year of birth, marital state, present employment, particulars of qualifications and experience and of war service, if any, should reach the Officer-in-Charge, Wildlife Survey Section, C.S.I.R.O., P.O. Box 109, City, Canberra, A.C.T., by 12th July, 1957.

F. G. NICHOLLS,
Research Secretary.
(Scientific Services.)

Commonwealth Scientific and Industrial Research Organization,
314 Albert Street,
East Melbourne, C.2, Victoria.

TECHNICAL PAPERS

A PHYSICAL ASSESSMENT OF FARM PRODUCTIVITY

By D. H. PENNY and F. G. JARRETT

It is a common practice to use various measures of production in assessing the intensity and efficiency of farm operation. In dairying, the figure often used is production of butterfat per acre (Hutton 1954, Bureau of Agricultural Economics 1956). This figure is apt to be misleading, however, where a proportion of the inputs do not come from the farm itself. The difficulty then arises as to the proportion of total output on each farm that should be attributed to inputs not farm produced.

In a Farm Management Survey (unpublished, 1955-56) of the Murray Swamps Dairying Area in South Australia* an attempt has been made to assess the contribution to total production made by the irrigated swamp area on each property. As a first approximation, total production of butterfat on each farm could be divided by the number of swamp acres to get a figure for butterfat per acre. The specific contribution of these swamp areas varies a great deal, however, from farm to farm. Each farm has associated with it an area of highland, on which the herd is grazed for part of the year, and from which oaten hay may also be made. The purchase of hay, and to a lesser extent, of concentrates, is likewise a common practice. In many cases, too, all young stock are agisted off the property for a period. It is clear therefore, that a different proportion of production on each farm is attributable to the swamp area.

Table I shows some relevant farm characteristics.

TABLE I.
Some farm characteristics. Farm Averages (1955-56).

	Jervois	Other Swamps
Reclaimed Swamp (acres)	49.2	49.7
Highland — arable, or suitable for grazing (acres)	166.3	80.8
Production (lbs/Butterfat)	15,400	12,200
Cow Numbers—		
Jerseys	23.4	10.4
Friesians	35.6	32.5
Butterfat per cow—		
Jerseys (lbs)	268	250
Friesians (lbs)	256	293

The contribution of highland grazing (for both milking and dry stock), agistment, bought hay, and oaten hay made on the highland, must be allowed for in arriving at a picture of production per swamp acre. Accurate input-output re-

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*The Murray Swamps lie within 20 miles north and south of Murray Bridge on the Lower Murray. The annual rainfall is 11-16 inches in the area. A total area of 13,000 acres was reclaimed from the river from 1900-1927. Of some 270 holdings, 223 farms have in excess of 20 acres of reclaimed land, and are used predominantly for dairying. The reclaimed area is flood irrigated. A simple random sample of 48 farms was taken from the 223 holdings.

Associated with each swamp holding is a varying area of "highland", which is not flood irrigated. The largest single reclaimed swamp, both in total acreage and number of farms, is Jervois. Of the sample of 48 farms, 21 came from Jervois. The remaining 27 came from all the other swamps together.

lationships are not, however, available to enable these calculations to be made with a great degree of certainty. However, in what follows an attempt has been made to assess the value of the non-swamp contribution.

Information was collected from each farm on:—

(a) amount of highland grazing obtained by the herd, for both milkers and dry stock. Data were expressed in cow-weeks.
(b) number, period, and payment for young stock sent away on an agistment basis.
(c) tonnage of oaten hay made on highland area.
(d) tonnage of hay and other feeds bought.

Together these inputs represent the total of non-swamp inputs.

Assumptions underlying the method used are that:—

(a) all meadow and oaten hay bought is of the same quality. All bought hay was valued at £10 per ton, delivered to the property. (This figure is an average for the farms in the survey.)

TABLE II.

Average per farm, 1955-56.
Non swamp inputs.

	Jervois	Other Swamps
Highland (oaten) Hay (tons) . ..	20.7	11.2
Bought hay—		
Pasture (tons) .	3.1	3.1
Cereal, etc. (tons)	26.1	18.2
Concentrates (tons)	(£17) 1.7	(£22) 2.2
Agistment (tons) .	(£21) 2.1	(£21) 2.1
Total "Hay" (tons)	53.7	36.8
Highland Grazing—		
Milkers (Cow weeks)	346	225
Dry stock (Cow weeks)	168	62

(b) concentrates bought were expressed in value terms, and converted to a "hay" basis, hay valued at £10 per ton.
(c) the value of agistment was likewise assessed on a "hay" basis.

All non-swamp inputs, save highland grazing, were therefore converted to a "hay" basis. The total non-swamp inputs is shown in Table II.

The total needs of the herd have been expressed in terms of cow weeks, i.e., the average size of milking herd was multiplied by 52. The herd sizes for both areas were practically stationary over the period under study. See Table III.

TABLE III.

Herd size—milkers.

	1/7/55	1/7/56	Average
Jervois	58.1	59.5	58.8
Other Swamps	42.1	44.0	43.0

The number of cow weeks required are, therefore, 3,058 and 2,236 for Jervois and Other Swamps respectively.

The question now posed is how many cow weeks are represented by the amount of "hay" fed? (See Table II.) Owing to the inadequate experimental information available, consideration of feed supplementaries has had to be ignored. To determine the butterfat value of the "hay" input it was first assumed that the "hay" was fed to the herd over a concentrated period and was the only feed available in that period. An attempt was made to determine the hay and concentrate requirements for various levels of production.

This calculation was based on Table XVI of Hewitt (1953). This table, portion of which is reproduced in Table IV, shows the amount of hay and concentrates required for dry-lot feeding of three breeds of cows at different levels of production. The concentrates in this table were converted to a hay basis by

TABLE IV.

Feeding Table for cows wholly hand fed and housed (daily, in lbs).

Required for	Jerseys and Guernseys		Friesians	
	Hay	Concentrates	Hay	Concentrates
Maintenance	15	—	21	—
Maintenance + one gal/day	23	—	28	—
Maintenance + two gal/day	17	7	28	3
Maintenance + three gal/day	14	12	29	6
Maintenance + four gal/day	12	16	25	12

means of starch equivalents, concentrates being assessed at 1.5 times the value of hay.

To obtain feeding requirements for production levels intermediate between those recorded in Table IV a process of linear interpolation was carried out. The figures so obtained were "hay" (starch equivalent basis) requirements for various levels of butterfat production per year. These requirements were increased by one half to allow for:—

(a) The fact that the feed value of the concentrates is understated if converted on a starch equivalent basis only.
(b) The wastage of hay if fed in the paddock.
(c) The extra energy requirements of the stock if not stall fed.

Using the adjusted "hay" (starch equivalent basis) requirements, production in gallons was converted to lbs butterfat per year, assuming that Jerseys produced milk of 4.5 per cent. test and Friesians 3.5 per cent. test. These test figures were averages from the sample. A few of the "hay" (starch equivalent basis) requirements used subsequently in assessing the non-swamp contribution are shown in Table V. The reader should note that two conversions into "hay" have been performed. The first, the conversion of concentrates into "hay" on a value basis (Table II) and the second the conversion of concentrates into "hay" on a starch equivalent basis (Table V). The two procedures give almost identical results. Using starch equivalent figures from Hewitt (Average Hay, 40; Oats 69) one pound of oats is the equivalent of 1.73 lbs of hay. On a price basis the cost of oats per pound is 1.76 times the cost of a

TABLE V.

Modified Feeding Table, Portion Only.

lbs butterfat per cow per year	Friesian Gals/day, on 365 day basis. 3.5% test	Jersey Gals/day, on 365 day basis 4.5% test	Friesian "Hay" requirements per week (Tons)	Jersey "Hay" requirements per week (Tons)
250	1.90	1.48	0.150	0.119
260	1.98	1.54	0.152	0.119
270	2.05	1.60	0.155	0.120
280	2.13	1.66	0.156	0.122
290	2.20	1.72	0.159	0.123
300	2.28	1.78	0.161	0.125

pound of hay. The survey indicated that oats is the most commonly fed concentrate, and that its average price in 1955/56 was 19/- per bag (3 bushels).

The assumption of cow weeks being equivalent at various times of the year is suported by data from the survey indicating little seasonality in calving. The use of a 365 day period in Table V changes a 3 gallon Friesian cow, for example, with a lactation period of 250 days (the average for the sample) into a 2.05 gallon cow with a 365 day "lactation." Such a procedure may slightly overstate the annual feed requirements of such a cow. The effect of this overstatement is to lessen the non-swamp contribution to production in the calculations which follow so that our final figures on butterfat per swamp acre may err on the side of generosity.

It is interesting to note the comparison between the figures in Table V and those given by Wallace (1955). His figure for an 850 lb cow producing 250 lbs butterfat per year was 46 lbs dry matter per pound butterfat produced. Converting this dry matter figure to a hay requirement per week resulted in a figure of 0.116 tons of "hay" per week for an annual production of 250 lbs butterfat. The comparable figure for a production level of 300 lbs butterfat was 0.125 tons of "hay" per week. These figures compare very closely with the figures of 0.119 and 0.125 derived in Table V.

Following the previous assumption regarding the equivalence of cow weeks, the highland grazing by the milking herd must be reduced to allow for the hay fed whilst the herd is grazing on the highland. The survey showed that in Jervois the average amount of hay fed per cow per week during the period in which hand feeding was undertaken was 0.046 tons. For Other Swamps the rate of hay fed was 0.063 tons per week per cow.

Using the data in Table V the average "hay" requirements per cow per week were computed for the two areas. In Jervois the average butterfat production per cow is lower than in the Other Swamps and Jerseys are more common (see Table I). The herd type figures from the survey were used to obtain a weighted average of total "hay" requirements in the two areas. The figures used were 0.139 tons and 0.149 tons for Jervois and Other Swamps respectively.

The contribution of the highland must therefore be reduced in Jervois by 0.046 over 0.139 and in the Other Swamps by 0.063 over 0.149. For example, the average highland grazing for milkers in Jervois was 345 cow weeks. To allow for the hay fed while grazing on the highland this figure will be reduced to

$$345\left(1 - \frac{0.046}{0.139}\right) \text{ or } 231 \text{ cow weeks.}$$

Since dry stock are not fed hay the contribution of the highland grazing (expressed in cow weeks) is left unchanged. The highland contribution, expressed in cow weeks is shown in Table VI.

TABLE VI.
Highland contribution.
(*Cow weeks, average per farm.*)

	Jervois	Other Swamps
Highland Grazing (Milkers) unadjusted	345	225
Highland Grazing (Milkers) adjusted	231	130
Highland Grazing (Dry Stock)	168	62
Total	399	192

Using the average figures of 0.139 and 0.149 for Jervois and Other Swamps respectively, the "hay" fed can be converted to cow weeks. For Jervois the average quantity of "hay" fed per farm was 53.7 tons and for Other Swamps 36.8 tons. (See Table II.) These figures con-

vert to 386 cow weeks for Jervois and 247 cow weeks for Other Swamps.

Total non-swamp contribution is thus the sum of highland grazing obtained plus the feeding value of hay bought, or made on the highland. For Jervois, 785 ex 3,058 cow weeks of grazing, or 26 per cent. are attributable to "non-swamp" inputs. For Other Swamps, 439 ex 2,236 cow weeks or 20 per cent. of total inputs are attributable to "non-swamp" sources. Total production of butterfat is reduced by 26 per cent. in Jervois and 20 per cent. in Other Swamps to allow for these "non-swamp" inputs. Adjusted production divided by swamp acreage gives butterfat production per swamp acre.

On an unadjusted basis production per swamp acre (i.e., total production divided by number of swamp acres only) is 318 lbs butterfat for Jervois, and 249 lbs for Other Swamps. When adjusted for "non-swamp" inputs the figure reduces to 236 lbs butterfat and 200 lbs butterfat per swamp acre in each case.

The results so far have been given on an average basis only, but the same calculation has been made for each farm in the survey. On the basis of this procedure it has been found that output per swamp acre varies from 370 lbs butterfat per acre to 120 lbs butterfat per acre for the sample as a whole. The range in the percentage "non swamp" contribution in each area is from 1 per cent. to 55 per cent. in Jervois, and from —10 per cent. to 44 per cent. in the Other Swamps.**

In the Murray Swamps area, there is a considerable difference in soil type and pasture cover between the reclaimed area and the highland. However, data (Taylor and Poole 1931) suggest a great deal of homogeneity in soil type in the reclaimed areas so that variation in soil type should not be a major source of difference between farms in butterfat output per swamp acre. In other dairying areas it may be less difficult to determine a reasonable figure for output per acre (total farm) or output per acre of improved pasture owing to greater homogeneity in soil types, and less dependence upon bought fodder.

**A negative "non-swamp" contribution results from the sale of meadow hay made on the swamp.

Summary

The use of inputs produced off the farm (agistment, bought hay, concentrates, etc.) must be taken into account in arriving at a measure of butterfat production per acre. This paper has attempted to assess the contribution of such inputs to production. The existence of such widely divergent land types represented by the reclaimed areas on the one hand and arid highland on the other, makes further adjustments necessary.

The degree of approximation, which lack of experimental data makes necessary, should incline the reader to treat the final results with caution. However, it is hoped that this attempt will show the need for information on the contributions to production of the type of inputs considered above.

It is interesting, moreover, to compare the butterfat per acre figures, converted according to Wallace (1955) with the dry-matter per acre production from pastures in the reclaimed areas recorded by Richardson (1932) and Trumble and Davies (1934) in 1930-1933. These workers recorded a maximum annual pasture production of 24,500 lbs dry matter per year (Richardson 1932) with an average yield of more than 18,000 lbs of dry matter at Woods Point, one of the reclaimed swamps. On the basis of Wallace (1955) a pasture producing 14,000 lbs of dry matter per acre per year when grazed by cows of 250 lbs butterfat per year capacity will result in a per acre yield of 303 lbs butterfat per year. From the survey the average butter fat per cow figure was 270 lbs, that is, cows of greater inherent capacity than

those taken from Wallace. Thus if the Swamp pastures produce 14,000 lbs dry matter such cows should result in a butterfat per acre figure in excess of 303 lbs. On the basis of our calculation the butterfat per swamp acre was 200 for Other Swamps and 236 for Jervois. The implication clearly is that the swamp pastures are yielding far less than Richardson *et al* had shown to be possible in 1930-33.

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(*Received for publication, November* 28, 1956).

APPOINTMENTS AVAILABLE — *See also pages 137, 148, 167, 179, vii.*

AGRICULTURAL SCIENTIST

Applications are invited from graduates in Agricultural Science, or holders of a diploma from a recognised agricultural college, for the position of Agricultural Field Officer with a large Queensland Pastoral Company undertaking sorghum farming and experimental pasture improvement work in the Central, Southern and North-Western districts of Queensland.

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THE RELATION OF DISTRICTS AND OF BLUE MOULD IN SEED BEDS TO LOSS OF TOBACCO IN FIELDS IN NORTH QUEENSLAND

By H. R. ANGELL

Summary and Conclusions

A survey was made in 1956 of seedbeds and fields in the tobacco-growing areas of Ayr, Clare, Millaroo and Dalbeg on the Burdekin River, and Mareeba and Dimbulah, North Queensland.

Blue mould overwintered on *Nicotiana glauca* and on *N. tabacum* in the districts along the Burdekin and on *N. tabacum* in Mareeba-Dimbulah.

Seedbed management for control of blue mould was entirely unsatisfactory on many farms. Dry farming of seedbeds and too little benzol at too great intervals sometimes masked the disease.

On account of the careless use of benzol, seedbeds on more than one-half the farms inspected in Mareeba and on one-third of those in all the districts were infected with blue mould. After transplanting, the disease spread to nearly all fields. Practically complete destruction of all leaves (three to eight per plant) occurred in the Burdekin area three to five weeks after transplanting. Although inoculum was initially more widely distributed in the Mareeba-Dimbulah area no epiphytotic occurred during the period of these investigations. The average loss on 49 farms planted with healthy seedlings in Mareeba-Dimbulah was 7 per cent. and on 43 farms planted with seedlings from diseased beds, 25 per cent.

As in Gunbower, Vic., blue mould in Mareeba-Dimbulah rarely causes much loss in fields transplanted with healthy seedlings. In the Burdekin area, as in the Ovens River Valley in Victoria, severe loss may occur in fields planted with healthy seedlings.

Introduction

Field investigations made in Victoria in the 1954-55 and 1955-56 seasons revealed that in the Gunbower area blue mould of tobacco was economically important only in fields planted from diseased seedbeds. There was but a fraction of one per cent. of loss in fields planted with healthy seedlings. In contrast with this very satisfactory limitation of the disease to fields in which it was introduced in the seedlings, its distribution was general in fields in the Ovens River Valley a few weeks after transplanting, and losses ranging from 20 to 100 per cent. were sustained, irrespective of the health of the seedlings transplanted. A similar study was made in the tobacco-growing districts of Clare, Millaroo and Dalbeg on the Burdekin River, and Mareeba and Dimbulah on the fringe of the Atherton tableland during the period August 17 to November 10, 1956, and is here reported.

Methods and Results

(a) *Seedbeds*

Seedbeds on as many farms as possible were inspected in each district. The absence, and where practicable, the extent of blue mould infection, were recorded. A summary of blue mould incidence in the seedbeds on 218 farms is given in Table I. The high proportion of farms with infected seedbeds is very unsatisfactory, especially in the Mareeba district. Owing to the extremely harsh conditions imposed by most growers on their seedlings, it was sometimes impossible to decide whether the peculiar yellowish green of the foliage was due only to the artificial shortage of soil water and plant food or in part to blue mould infection

TABLE I.

Occurrence of blue mould in seedbeds in North Queensland.

Numbers of farms visited.

District	With Healthy Seedbeds	With Diseased Seedbeds	Doubtful	Total
Clare	30	9	0	39
Millaroo	33	6	0	39
Dalbeg	18	2	0	20
Mareeba . . .	26	38	7	71
Dimbulah . .	30	17	2	49
Total	137	72	9	218

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which was masked under those conditions. Before the writer's visit, the disease had been brought under control on some farms. During his survey it was eliminated from a few beds of recently infected young seedlings by using 2 sq. in. of evaporating surface of benzol per square foot of bed on seven successive nights.

(b) *Fields*

Transplants were inspected at three-weekly intervals. On the first inspection, the percentages infected were ascertained by counting the number in a few hundred plants in rows taken at random. These figures are not dealt with in this paper.

Four to six weeks after transplanting, when leaves of commercial size numbered three to eight, all such leaves throughout the districts on the Burdekin river were heavily and uniformly spotted, and were consequently useless commercially. The attack was severe enough to retard growth temporarily. As total loss of leaf occurred, tabulation of such results is unnecessary.

Many fields in the Mareeba and Dimbulah districts were in flower when the final estimates of damage by blue mould were made. Loss from leaf spotting was estimated after inspection of plants in all parts of each field. The percentage of loss from such damaged or destroyed leaves was added to the percentage of plants whose growth was prematurely arrested by, or had died from, stem infection. The numbers per 100 plants were counted in the sixth and twelfth rows from the point of entry into the field.

The results of the final observations in Mareeba and Dimbulah are given in Table II. With two exceptions, the loss in fields planted with healthy seedlings is small, averaging 7 per cent., but in fields planted from diseased seedbeds it is 25 per cent.

At or near maturity there were great differences between the effects of blue mould in fields planted with healthy seedlings and those planted with diseased seedlings. If healthy seedlings were planted, only leaves near the ground were destroyed or sufficiently injured by blue mould to cause a small percentage loss. If seedlings from diseased beds were used, no such spotting was observable at or

TABLE II.

Percentage loss by blue mould in fields planted with healthy or diseased seedlings in the Mareeba and Dimbulah districts.

Percentage loss on each farm

Seedlings healthy		Seedlings diseased	
in Mareeba	in Dimbulah	in Mareeba	in Dimbulah
1	0	4	4
1	0	6	7
1	0	7	10
1	0	12	15
1	0	12	15
1	0	13	17
3	0	14	20
6	1	15	20
6	1	16	20
6	3	20	26
6	3	22	26
6	4	24	45
6	4	24	50
7	4	25	50
8	5	26	
9	6	26	
9	6	27	
9	7	27	
12	7	32	
12	9	35	
12	11	35	
12	14	35	
13	44	36	
16		37	
16		38	
27		39	
		44	
		50	
		65	
Totals 207	129	766	325
Mean 7.96	5.6	26.4	23.2
Mean of all from healthy seedlings 6.86		Mean of all from diseased seedlings 25.3	

near maturity. Diseased leaves in such plantings were produced only directly after transplanting and were covered in the routine mounding up of plants in the rows. Instead of destruction of leaves of commercial size by spotting, death or arrest of growth at any stage of plant development was the source of loss in such fields.

Discussion

When the protection of tobacco seedlings by benzol was being devised it was expected that in order to save time and money, seedlings would be grown as quickly as possible and transplanted as soon as they were ready. Because benzol properly used is unique in that it gives complete protection from blue mould and does not merely control it, the seedlings in the early experiments were grown under optimal soil and moisture conditions, and benzol was applied every night at the rate of two sq. inches evaporating surface per square foot of bed. Under these conditions any infection which started during the day was eliminated during the night, the pathogen being killed.

In North Queensland the usual practice appears to be to apply benzol in any readily available can once in every three, four or five nights. One successful grower, using the covers night and day, applies benzol at one and one-half sq. in. per sq. foot of bed, on the average once every one and one-half days. Most farmers mistakenly try to compensate for their deficient benzol programme by keepings their seedlings as dry as possible. Under such a combination of inadequate benzol and dry conditions, blue mould can and does infect the seedlings. The usual symptoms, observable on plants in the open, are masked, and some farmers appear to be satisfied if systemic blue mould—discolouration of the stem —is not detectable. This attitude was often necessary in the pre-benzol days, but is inexcusable now.

In contrast with the water restrictions imposed by growers while the seedlings are in the beds are two necessary irrigations, one during, the other immediately after, transplanting. Soil moisture being adequate, growth of the transplants begins. If the seedlings are infected, blue mould immediately appears on the developing leaves. Leaving fields of such infected transplants for five to six weeks without watering is fairly general practice which has its origin in the mistaken belief of growers that infected plants so treated become healthy. In fact, the diseased leaves dry up and disappear, but in the meantime the stems may become infected. If this happens, transplants may die soon after transplanting, or growth may be arrested before maturity, or fully grown plants may snap off at the base in windy weather. Leaf spotting on plants with infected stems is seldom as pronounced as that on plants from healthy seedbeds. It is this contrast, apparently favouring diseased seedlings, which distracts attention of growers from the much greater losses suffered from incomplete stands and the depreciated quality of leaf grown under dry conditions.

The tobacco districts of Ayr, and Clare, are separated by 25 miles of cultivated or bush land, Clare and Millaroo and Dalbeg by five miles of hills. The Ayr and Clare districts were established in 1948, Millaroo in 1955 and Dalbeg in the present season, 1956. Fields in some parts of each of these districts are contiguous and are therefore in effect, extensive plantings in which there is no break to retard the spread of blue mould. The most obvious host on which blue mould overwinters in these areas is *N. glauca* but there are only a few scattered plants in each district. Infected seedlings and plants occur in or on the banks of irrigation channels, in burnt-over areas, and were even seen within a seedbed enclosure in the newly established area of Dalbeg. It is doubtful if infected *N. glauca* has been seen before in such close proximity to cultivated tobacco in Australia.

Properly used, benzol reduces the importance of overwintering tobacco and other species of *Nicotiana* by delaying the appearance of blue mould in the new season from the seedling stage, at which it kills the greater number of infected hosts, to after transplanting in the field, when it is tolerated by the host. In this environment such a short delay of initiation of infection is of little avail. Elimination of the overwintering hosts, further to reduce the chances of infection in the field is essential. Although the number of infected seedbeds this season was small in comparison with the numbers in the more northerly areas, spread throughout fields was rapid and destruction of leaf was uniformly severe. Such uniform destruction showed that neither the provision of healthy seedlings by individual farmers, variation in the date of planting or other details of farming practice throughout the area was of any avail against the weather conditions which prevailed this season after transplanting. The standard of seedbed hygiene must therefore be raised so that no fields of diseased transplants are established each year to inoculate the area.

The Mareeba-Dimbulah area on which tobacco has been grown since 1930 is on the fringe of the Atherton tableland. Tobacco fields in these two districts are less than 20 miles apart. The fields are in small areas of irrigable lands in hilly country. Only in two parts of the Mareeba district are a few of the fields contiguous. No *N. glauca* was seen in or near this district, but instead the means by which blue mould overwintered was provided by the tobacco growers. Plants which had overwintered were found in fields, by the side of the road and around farm buildings. Unprotected diseased seedlings were seen within seedbed enclosures and in market gardens on the site of the previous season's tobacco. The general environmental conditions which prevail during late Spring and Summer are unfavourable to destructive outbreaks of blue mould. These conditions and the proper use of benzol are two powerful tools which can be used to reduce loss in the field considerably. The number of farms on which diseased seedlings were transplanted (55 out of 120) was more than sufficient to provide inoculum for the spread of blue mould to all other farms. But although the inoculum was provided, blue mould did not become epiprytotic because environmental conditions were unfavourable.

Perhaps one of the factors which is responsible for the indifference of most tobacco farmers in Mareeba and Dimbulah to blue mould in seedbeds (Table I) is the relative freedom from very heavy, sometimes total loss which, in other districts would result from transplanting diseased seedlings. The average loss from such plantings this season was 25 per cent. One instance of a stand equal to that obtained with healthy seedlings was noted on a farm on which blue mould was distributed throughout the seedbeds. Such rare exceptions, although of interest to the pathologist, should not distract attention from the large numbers of farms on which the reduction in yield is large enough to cause serious loss of income.

In contrast with this example is one in Table II in which the loss of leaf on a farm planted with healthy seedlings was nearly 50 per cent. There was another instance of even greater loss in a planting about 20 miles from Mareeba. Both of these farms were the earliest planted in their districts. It is indeed remarkable that after the rain which was generally distributed, these early-planted crops were the only ones in which blue mould was destructive. The general trend in the Mareeba and Dimbulah districts is now towards late planting.

Control of blue mould in most fields planted with healthy seedlings is satisfactory and should improve when, by proper use of benzol, few if any diseased seedlings are transplanted, providing inoculum for the district.

Acknowledgments

The writer is grateful to all who facilitated the undertaking, or helped in the prosecution of this aspect of the blue mould problem, especially members of the staff of the Queensland Department of Agriculture, the British-Australasian Tobacco Co., and the local growers' association.

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BOOK LIST

Notice has been received that the following books on agricultural topics have been published recently:—

AGRICULTURAL RESEARCH COUNCIL.—Report Series, No. 14. Investigations of virus diseases of brassica crops, by L. Broadbent. *Cambridge, University Press,* 1957. (Price not known.)

BRITISH SOCIETY OF ANIMAL PRODUCTION.—Proceedings, 1956. *Edinburgh, Oliver & Boyd,* 1956. 15/-.

BROSS, Irwin D.—Design for decision. *New York, Macmillan,* 1953. 40/3.

COMMONWEALTH BUREAU OF ANIMAL NUTRITION.—Tech. Communication, No. 15. Minerals in pasture: deficiencies and excesses in relation to animal health. 2nd ed. *Farnham Royal, C.A.B.,* 1956. 25/- stg.

COMMONWEALTH BUREAU OF PASTURES AND FIELD CROPS.—Bulletin 44. The underground organs of herbage grasses, by Arthur Troughton, 1957. 25/- stg.

DUDDINGTON, C. L.—The friendly fungi: a new approach to the eelworm problem. *London, Faber & Faber,* 1957. 21/- stg.

FOOD AND AGRICULTURAL ORGANISATION OF THE UNITED NATIONS.—Recent developments affecting livestock in the Americas. (F.A.O. Agricultural Development Paper No. 55.) *Rome, F.A.O.,* 1956. 7/6 stg.

FOOD AND AGRICULTURAL ORGANISATION OF THE UNITED NATIONS.—Trichomonas foetus infection of cattle. (F.A.O. Agricultural Study 33.) *Rome, F.A.O.,* 1956. 2/6 stg.

McCULLOCH, Alan W., and SCHRUNK, John F.—Sprinkler irrigation. *Washington, Sprinkler Irrigation Association,* 1955. £6/17/-.

MAHLSTEDE, John P., and HABER, Ernest S.—Plant propagation. *New York, John Wiley,* 1957. $7.50.

NORTH CENTRAL (U.S.) WEED CONTROL CONFERENCE.—Thirteenth Annual Research Report. (Price not known.)

APPOINTMENTS AVAILABLE — *See also pages 137, 143, 167, 179, vii.*

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LIGHT LAMBS FROM OVERFAT EWES

Two groups of 120 ewes were divided into four equal size age groups from two-tooth to full mouth and run on different levels of nutrition from mating till the lambs were weaned, i.e., almost 12 months. The lambs were weaned one month before shearing.

The experiment was run on what was then the Long Range Weapons Establishment, Salisbury, on the Adelaide Plains, 15 miles north of Adelaide in 1953 and 1954. All sheep had grazed together on lucerne paddocks prior to the experiment and were in fat condition.

Group 1 was run on lucerne continuously and when paddock feed became scarce in the long dry autumn of 1953, supplements of lucerne hay and cut green lucerne were offered. The hay was offered ad lib. and a lorryload of green irrigated lucerne once per week.

Group 2 was run on unimproved annual grass paddocks from mating till weaning of the lambs. Any supplements offered during the long dry autumn were baled oaten and grass hay fed ad lib.

After weaning, both groups were combined and run together on lucerne.

Results

Group 1 ewes averaged 131 lbs bodyweight one month before lambing and were in very fat condition. Group 2 ewes averaged 119 lbs bodyweight one month before lambing, and were in forward store to fat condition.

The lambing results are set out in Table I.

The birthweight of lambs in the two groups was most interesting. These are set out in Table II. Group 2 lambs were significantly heavier than Group 1 lambs ($P = .001$). Although there were 26 sets of twins in Group 1 and only 9 sets in Group 2, this fact did not alter the overall picture.

TABLE II.

Average birthweight of lambs (lbs).

	Group 1	Group 2
Single male	8.6	9.7
Single female	7.8	9.5
Twin male	7.3	7.7
Twin female	6.2	7.7
Overall average	7.3	9.2

There was no significant effect of sex on birthweight in this experiment but single lambs were significantly heavier in Group 2 than in Group 1 ($P = .001$).

There was also a much higher lamb mortality in the Group 1 lambs as seen from Table I and more difficulty at lamb-

TABLE I.

Lambing results.

	No. of ewes mated	No. of lambs born	% lambs born	No. of lambs marked	% lambs marked
Group 1	120	123	103	108	90
Group 2	120	115	95	106	88

ing with the ewes. The ewes however did cut more wool due to better feeding.

The age of dam had a significant effect on lamb birthweight. Two tooth ewes had lighter lambs than older ewes ($P = .001$). There was no significant difference between the birthweight of lambs from four-tooth, six-tooth and full mouth ewes. Lambs from two tooth ewes had an average weight of 7.8 lbs and lambs from older ewes 9.2 lbs.

Summary

In this experiment overfat ewes had light lambs and suffered lambing difficulties. Although the ewes cut more wool, it was not warranted for the extra feed given.

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A USEFUL DEVICE FOR HANDLING ACTIVE INSECTS

The transfer from cage to cage of small, active insects where accurate counts are essential, often presents problems. To overcome this difficulty in the handling of small leafhoppers (*Cicadellidae*) used in the study of the transmission of plant virus diseases, the following equipment was designed and made in the C.S.I.R.O., Division of Entomology workshops.

The first piece of the equipment is an improved type of venturi sucker using compressed air. This unit, Figure 1, is made of brass tubing and incorporates a shut off valve that is operated by the thumb or finger so that compressed air may be used economically. The valve is spring loaded and automatically shuts off the air flow when released. The size of the venturi is such that an operating air pressure of 10-12 lbs sq. in. is sufficient to initiate suction through the intake of the collecting tube and draw in soft bodied

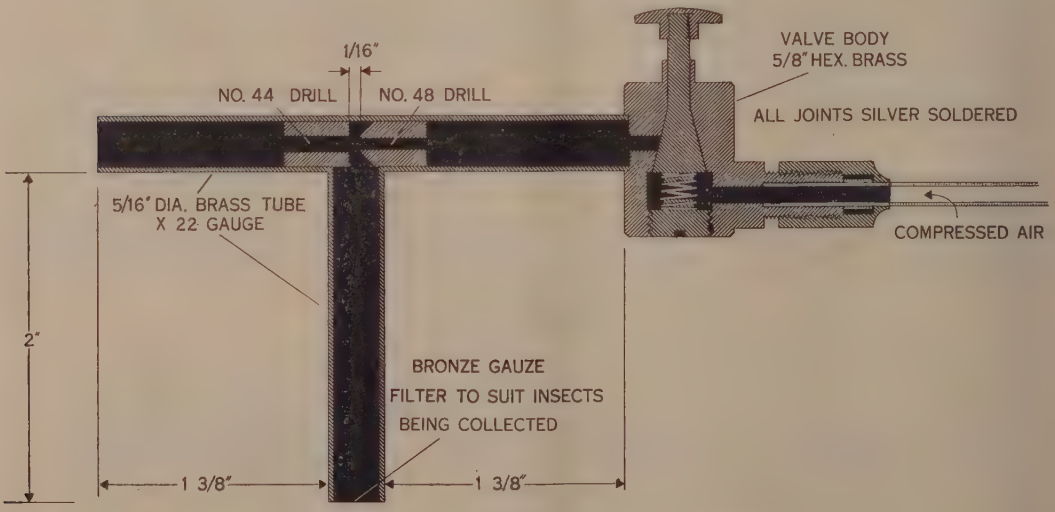

Figure 1.
Cutaway section showing details of the improved type venturi sucker.

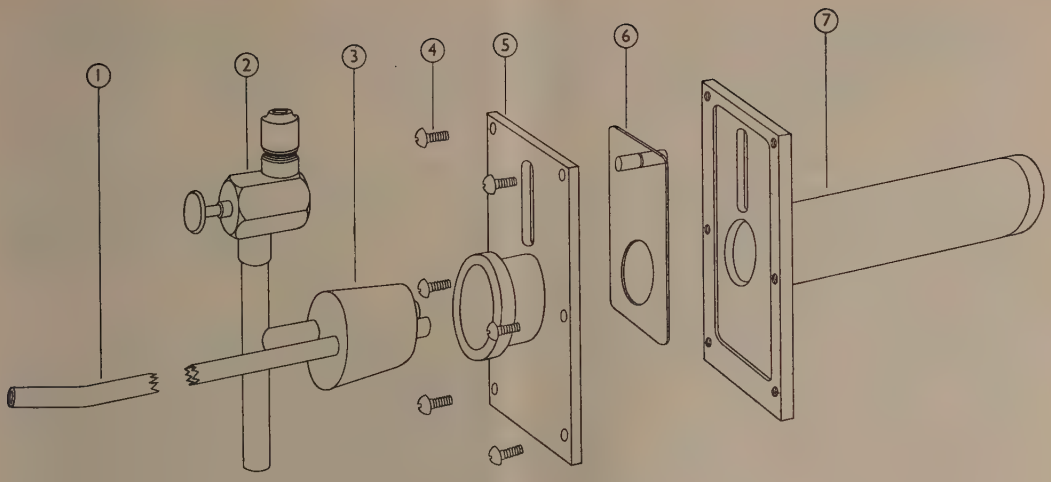

Figure 2.

'Perspex' collecting tube and sucker. (Exploded view showing working parts.)

insects such as the *Cicadellidae* efficiently but without damage. A bronze gauze filter soldered over the end section of the brass tube within the collecting tube prevents the insects from entering the venturi.

The second part of the apparatus is used for collecting and holding insects during transfer. Essentially, it consists of a 6 inch length of 1 inch diameter 'Perspex' tube closed at one end and to the other is fitted an attachment with a sliding plastic or celluloid shutter. (Figure 2). The venturi type sucker and glass intake tube of the required size are inserted through a rubber stopper forming a close fit in the mouth of the plastic tube. The shutter is set with the opening coinciding with the bore of the tube. When the insects are collected they are lodged in the bottom section of the tube by a few smart taps at the top of the tube while it is held in a vertical position. The shutter may then be closed and the insects counted through the transparent walls of the tube. To transfer the insects to cages, the venturi sucker is removed, the tube is inverted and the shutter opened. A few smart taps on the bottom of the tube ejects the insects. This apparatus has proved extremely useful for handling leafhoppers especially when used in conjunction with celluloid and organdie cages with an opening in the top of the same diameter as the bore of the collecting tube. The opening may be closed with a rubber or cork stopper after the insects are placed in the cages.

Although the above apparatus was designed and has been used largely for handling small insects, it could conceivably be used for other purposes such as the collection of small seeds. The size and shape of the intake tube may be modified to suit the purpose for which it is required and the air pressure may also be varied.

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FUSARIUM WILT OF ROCKMELLON (*CUCUMIS MELO L.*) IN NEW SOUTH WALES

Summary

Fusarium wilt of rockmelon was first recorded in New South Wales in 1955. A field trial, carried out in the infested area, has indicated that the variety Delicious 51 was resistant to the disease under conditions which favoured a severe attack on susceptible varieties. Some seedling rot, resulting from attack by the Fusarium wilt organism, occurred in Delicious 51. It is thought possible that low temperatures may have induced some breakdown in the resistance of some of the older Delicious 51 plants.

History and Economic Importance

Fusarium wilt of rockmelon (*Fusarium oxysporum* Schlecht. f. *melonis* (Leach and Currence, Synd. and Hans.) was first recorded, in Minnesota, in 1932 (Leach 1933) and, since that time, has assumed considerable importance in the northern rockmelon growing States of the U.S.A. (Walker 1952). In Canada, the disease is reported to have first appeared in 1936 and by 1951 was well established in the rockmelon growing areas of the Ontario province (McKeen 1951).

In New South Wales, the disease was observed for the first time in February, 1955. The outbreak had occurred in a small market garden at Brookvale in the Sydney Metropolitan Area. This garden had been cropped with rockmelons over many years but the grower had not previously noted the disease. The variety involved was the grower's own selection. It was not one of the commonly grown varieties and it has not been possible to identify it. The origin of the infection is obscure as this selection had been grown for the last ten years and no new planting stock had been introduced in that time.

At the time the crop was inspected, all plants were affected and many had completely wilted. The symptoms exhibited by the plants were identical with those described by Leach and Currence (1938). Isolations were made from infested stems and fruits and the pathogenicity of the isolates was confirmed by growing plants of the variety Benders Surprise in steam sterilized glasshouse soil which had been artificially infested with the organism.

The destructive nature of Fusarium wilt of rockmelon is well illustrated by reports from the United States and Canada (Leach 1933, McKeen 1951) and in the outbreak at Brookvale. Although this latter is the only record of the disease in New South Wales to date, the presence of the pathogen in the coastal area could represent a potential hazard to early rockmelon culture.

Field Test at Brookvale 1955/56

As no resistance to Fusarium wilt has been reported in the rockmelon varieties most commonly grown on the New South Wales coast, a field trial was carried out in the infested area at Brookvale in which the reaction of the varieties Bender's Surprise, Hales Best and Powdery Mildew Resistant 45 (P.M.R.45) was compared with that of the U.S. variety Delicious 51. This latter variety was bred at Cornell University Agricultural Experiment Station and is reported to be resistant to Fusarium wilt in the United States (Munger and Newhall 1953). Delicious 51 is comparable with the other three varieties in maturity time.

The trial was laid down in October 1955 when 12 hills each 3 to 4 feet diameter were prepared. In each of 6 of the hills were planted seeds of the 4 varieties (6 seeds of Bender's Surprise, 5 of Hales Best and 8 each of P.M.R.45 and Delicious 51). Into each of the remaining 6 hills were transplanted four seedlings of each variety at the 2-4 leaf stage. These seedlings had been raised in pots of steam sterilized glass house soil. During growth the plants were side-

dressed with complete fertilizer and sprayed with insecticide to control 28-spotted ladybird (*Epilachna 28-punctata (F.)*). The plants were examined periodically during the season and the incidence of Fusarium seedling rot and of Fusarium wilt noted. The pathogen was isolated in all cases from affected seedlings and plants. The results are set out in Table I.

Discussion of Results

The results indicate that, under the conditions of the experiment at Brookvale, the Delicious 51 variety of rockmelon showed a high field resistance to Fusarium wilt. Only 17.8 per cent. loss occurred in seedlings and plants of this variety compared with 96 per cent. in Bender's Surprise, 92.3 per cent. in Hales Best and 82.5 per cent. in P.M.R.45. Half the loss in Delicious 51 occurred as a seedling rot, i.e., a rot of the root and hypocotyl resulting in a collapse of the seedlings. This seedling rot occurred with both direct seeded and transplanted seedlings. This phase of attack by the Fusarium wilt pathogen has been referred to by Leach and Currence (1938) as occurring on field susceptible rockmelon varieties in cool weather when soil temperature is low and it would appear that some seedling rot could be expected in the Delicious 51 variety in cool soils. Porter (1937) and Wilson (1936) have reported that a seedling rot, resulting from attack by *F. oxysporum* Schlecht. f. *niveum* (E.F.Sm.) Synd. and Hans. can occur in wilt resistant watermelon varieties.

The loss of a further 8.9 per cent. of the Delicious 51 plants up to 51 days after planting was the result of a definite vascular wilt. It is probably significant that these plants wilted at a time when the greatest percentage increase in wilt incidence occurred in the other three varieties but thereafter there was no further incidence of wilt in the Delicious 51 plants and a slower increase in the incidence of wilt in the other three varieties. The spring and early summer maximum daily temperatures in the Sydney Metropolitan Area in 1955 were below 27°C on most days and often below 20°C and thus were not favourable for rockmelon growth. This fact was reflected in relatively slow vine growth and delay in the maturity of the first fruits of the varieties (94-100 days) when normally

TABLE I.

Field reaction of four rockmelon varieties to Fusarium seedling rot and Fusarium wilt. Brookvale, N.S.W., 1955/56 (*Total of all hills*).

Variety	Seed Germination	Total No. of Plants	Days after planting							
			30		51		80		114	
			H* (%)	SR** (%)	H (%)	W*** (%)	H (%)	W (%)	H (%)	W (%)
Bender's Surprise	1/36	25	100.0	0.0	36.0	64.0	24.0	76.0	4.0	96.0
Hales Best	28/30	52	78.9	21.1	17.3	82.7	15.4	84.6	7.7	92.3
P.M.R.45	16/48	40	67.5	32.5	27.5	72.5	22.5	77.5	17.5	82.5
Delicious 51	21/48	45	91.1	8.9	82.2	17.8	82.2	17.8	82.2	17.8

* Healthy. **Seedling rot. *** Wilted (including seedling rot)
Figures are based on transplants plus plants which emerged from seed. Cold conditions depressed germination considerably in Bender's Surprise and to a lesser extent in the other varieties.

the first fruits could be expected to have matured in 80-85 days from planting. Leach and Currence (1938) have shown that soil temperautres below 27°C were very favourable for the development of Fusarium wilt of rockmelon and that there was no critical temperature below which the host would grow and escape infection. The low temperatures experienced during the first half of the test period may have induced some breakdown in the field resistance of the Delicious 51 plants.

The performance of this variety in the field test gives encouragement in the hope of controlling possible future outbreaks of Fusarium wilt disease in the early rockmelon growing areas of New South Wales. However, Delicious 51 is susceptible to powdery mildew (*Erysiphe cichoracearum* DC) which is a major disease of coastal rockmelons in this State. Further breeding work would therefore be necessary to produce a variety with the characters of early maturity, Fusarium wilt and powdery mildew resistance, which would be required if Fusarium wilt assumes greater importance in the early rockmelon areas.

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SOME APPLE ROOTSTOCKS AND POTASSIUM

Summary

Apple rootstocks, propagated vegetatively from stoolbeds, were lined out in the nursery at Scoresby Horticultural Research Station, in a soil known to be deficient in potassium.

The various rootstock varieties reacted in widely differing degrees to the potassium deficiency.

Leaf analyses showed a close correlation between potassium content and the severity of symptoms. This appeared to be due to differences in potassium feeding efficiency, rather than to differences in cation antagonism.

A year later, a potassium-rich fertilizer dressing had corrected the deficiency, but it appeared that the scion varieties worked on the rootstocks had also modified potassium uptake.

Introduction

It is recognised that fruit trees on some vegetatively propagated rootstocks are relatively susceptible to potassium deficiency, due to differences in the ability of various stocks to utilize soil potassium (van Belle 1952, Goodall 1945). However, it appears that no information has been published on the susceptibility of some of the newly released Malling-Merton rootstocks to this deficiency.

During the 1951-52 season, newly planted apple rootstocks of the Malling-Merton series and a number of other types grown at Scoresby Horticultural Research Station showed strong differential reactions to the deficiency.

The soil type concerned was loam and clay loam 0-13 in. overlying yellow clay. It is of Silurian origin, and is common in the fruit growing districts east of Melbourne.

Inter alia, investigations carried out on the rootstocks yielded useful information on the comparative susceptibility to potassium deficiency of Northern Spy, the commonest apple rootstock in Victoria, and other rootstocks, and provided preliminary information on the susceptibility of a number of rootstocks at present under test for pomological value.

TABLE I.

Description of symptoms (March, 1952).

Rootstock	Symptoms
Northern Spy*	Leaf-edge yellowing; some premature loss of older leaves.
M IV	Leaf-edge scorch and yellowing; some premature loss of older leaves.
M VII*	Premature loss of older leaves.
M IX	Leaf-edge scorch; some premature loss of younger leaves.
M XII	Nil.
M XV	Some edge or tip scorching of younger leaves; some premature loss of older leaves.
M XVI	Nil.
M XXV*	Severe leaf-edge scorch; premature loss of younger leaves.
Mer.793*	Nil.
MM 103	Slight edge-scorching of younger leaves; premature loss of older leaves.
MM 104	Nil.
MM 106	Slight premature loss of older leaves.
MM 107	Slight leaf-edge scorch and yellowing.
MM 108	Leaf-edge scorch; some premature loss of younger leaves.
MM 109	Slight leaf-edge yellowing on and premature loss of old leaves.
MM 110	Slight leaf-edge yellowing on older leaves.
MM 111	No scorch; some premature loss of older leaves.
MM 112*	Leaf-edge scorch and yellowing; premature loss of a few younger leaves.
MM 113	Leaf-edge scorch and yellowing; premature loss of few younger leaves.
MM 114*	Nil.
MM 115	Some leaf-edge scorch and yellowing.
411	Leaf-edge scorch and yellowing.
279	Nil.

*Varieties selected for leaf analysis.

Method and Results

Rootstocks newly cut from the stoolbeds were lined out in nursery rows in winter 1951, in a part of the nursery which had previously shown symptoms of potassium deficiency. They received a light dressing of 2: 2: 1 complete fertilizer at planting.

The rootstocks planted were:

(a) Northern Spy.

(b) East Malling stocks M IV, VII, IX, XII, XV, XVI and XXV.

(c) Merton 793.

(d) Malling-Merton Immunes MM 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114 and 115.

(e) Malling-Merton selections 411, 279.

Rootstocks propagated vegetatively in this way have only a very small root system in relation to wood growth when planted; this may tend to increase their susceptibility to nutrient deficiencies during the first season of growth, due to relatively inefficient feeding.

During January-February, 1952, it was observed that different rootstocks in adjacent rows showed symptoms varying from advanced leaf-edge scorching and partial defoliation to normal health.

Foliar symptoms recorded in March 1952 are shown in Table I. Varieties selected for leaf analyses are indicated by an asterisk.

It was notable that in plants showing greater severity of leaf-edge scorching and yellowing, there was a tendency to loss of the younger leaves, rather than of the older leaves, which were more prone to shed in less severe cases.

The severity of symptoms was not related to the amount of root development when planted, e.g. M XII had very poor roots when planted; Mer.793 had strong

TABLE II.

Leaf analysis of selected rootstock varieties (March, 1952).

Rootstock	Symptoms (See Table I)	K (%)	Ca (%)	Mg (%)	Mn (p.p.m.)
MM 114	Nil	1.51	1.42	0.53	58
Mer.793	Nil	1.41	1.51	0.54	Not determined
Northern Spy	Slight	1.25	1.19	0.48	22
MM 112	Medium	0.94	1.18	0.49	Not determined
M VII	Medium	0.93	1.87	0.62	Not determined
M XXV	Severe	0.44	1.38	0.63	81

roots which were few in number; M XXV had good roots.

Leaf samples were collected at the time of this survey from selected rootstock varieties showing the range of symptoms noted.

To eliminate any error due to variation in the potassium content of younger and older leaves (Ljones 1951) all samples were collected from the middle of the seasonal growth.

Analyses for potassium, magnesium, calcium and manganese are given in Table II. These are on a dry weight basis.

Potassium content was closely related to the severity of symptoms observed. Calcium, magnesium, and manganese showed no relationship either to severity of symptoms or to potassium content.

There was no indication of K-Ca or K-Mg antagonism. This appeared to indicate that the rootstocks differed in potassium feeding efficiency, rather than in any tendency to take up antagonistic cations selectively.

TABLE III.

Soil analysis (March 1952).

Soil sample adjacent to rootstock variety:	pH	Exchangeable cations m.e.%		
		K	Ca	Mg
MM 114 (Nil)	5.0	0.40	4.24	1.04
M XXV (Severe)	5.0	0.36	4.14	1.03

Soil samples were collected in the immediate vicinity of two rootstock varieties showing the extreme range of symptoms, viz., MM 114 (nil) and M XXV (severe).

Since root development at this stage was still very shallow, the samples were compounded from a number of cores at 0-6 in. Analyses for pH and exchangeable potassium, calcium and magnesium were carried out. These are shown on Table III.

Since the rootstocks were required for the raising of experimental trees, they were budded with several commercial apple varieties, and during winter 1952 a complete fertilizer dressing rich in potassium was applied in an attempt to make up the deficiency.

No potassium deficiency symptoms were observed in the 1952-53 season. However further analyses for potassium and manganese were carried out on leaf samples collected in April 1953 from two scion varieties, Jonathan and Granny Smith, worked on rootstocks MM 114, M XXV and Northern Spy, and from some unworked plants of MM 114 and Northern Spy. (No unworked plants of M XXV were available.)

Analyses for potassium and manganese are given in Table IV. These are on a dry weight basis.

TABLE IV.
Leaf analysis of worked trees (April 1953).

Sample	K (%)	Mn (p.p.m.)
Granny Smith on M XXV	2.01	63
Jonathan on M XXV	1.99	76
Granny Smith on MM 114	2.21	71
Jonathan on MM 114	1.94	88
Granny Smith on Northern Spy	1.64	68
Jonathan on Northern Spy	1.76	72
MM 114 rootstock (unworked)	1.50	74
Northern Spy rootstock (unworked)	1.31	45

Potassium level in the worked trees was considerably higher than in the corresponding unworked stocks indicating that the scion varieties had influenced potassium uptake.

Since no sample of M XXV was available, no conclusion could be drawn as to whether its potassium content had been improved by the dressing. Unworked stocks of Northern Spy (slightly susceptible) showed a slight improvement, and those of MM 114 (not susceptible) virtually no change from the 1952 figures.

Conclusions

(a) On a potassium-deficient soil, a number of apple rootstock varieties lined out from stoolbeds reacted in widely varying degrees to the deficiency. It is considered that this field test was made more sensitive by the use of this sparsely-rooted material. The severity of symptoms was not related to the amount of root development when planted.

(b) Leaf analyses of selected rootstock varieties indicated that potassium content was closely related to the severity of symptoms observed, and that this was due to differences in potassium feeding efficiency rather than to differences in selectivity for antagonistic cations Ca and Mg. Manganese figures were in the normal range.

(c) Analyses on soil samples taken near the least and worst affected rootstock varieties showed a low general potassium level but no substantial differences in pH or exchangeable potassium, calcium or manganese between the samples.

(d) A survey a year later, after a potash-rich fertilizer dressing during winter, showed no symptoms of potassium deficiency on the scion varieties or unworked stocks. The scion varieties then growing on the trees had favourably influenced potassium uptake.

Evidence in part (d) was incomplete, however, in the absence of samples of the rootstock which had shown the severest symptoms in the first season.

Acknowledgment

Chemical analyses of leaves and soil samples were carried out by the State Laboratories.

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ROOT-KNOT NEMATODE RESISTANCE IN TWO PASTURE SPECIES OF *PHASEOLUS*

Phaseolus lathyroides L. has proved to be a useful sub-tropical pasture species with wide adaptation in coastal and sub-coastal Queensland. On friable and sandy soils it is often badly attacked by root-knot nematode. Field observations of plant populations have shown a lack of variation in nematode susceptibility and this is to be expected from its breeding habit which is one of close self-pollination. A search has been made within the genus *Phaseolus* to find other pasture types with high nematode resistance which could replace *P. lathyroides* or perhaps be crossed with it.

Two species, *P. bracteatus* Nees and Mart. and *P. atropurpureus* D.C., with some promise as pasture plants were examined in the field and appeared to be resistant to root-knot nematode. On the 23rd May, 1956, an experiment was commenced in a heated glasshouse with these two species and *P. lathyroides*. Light sandy soil from the ridges in the C.S.I.R.O. plots at Beerwah was used as here heavy root-knot nematode infection of white clover and moderate infection of *Indigofera endecaphylla* occurred. Seven inch pots were filled with the mixed soil. Six seedlings each of *P. atropurpureus* C.P.I. 16877, 16878, 16879 and 16897, and *P. bracteatus* C.P.I. 11833 were planted one to a pot and 36 seedlings of *P. lathyroides* 6 to a pot.

The plants were harvested 19 weeks later on the 15th October. Half the *P. lathyroides* plants had died and the survivors were stunted with roots severely affected with root-knot as shown on the left of Figure 1. All plants of the other two species survived and grew normally and no trace of root-knot could be found on their roots indicating a high level of nematode resistance. A plant of *P. bracteatus* is shown in the centre of Figure 1 with one of *P. atropurpureus* on the right. Mr. R. C. Colbran of the Department of Agriculture and Stock, Brisbane, identified the nematode attacking the roots of *P. lathyroides* as *Meloidogyne incognita* (Kofoid and White) Chitwood.

Figure 1.
Effect of root-knot nematode on three species of Phaseolus.

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(*Received for publication, February* 25, 1957).

THESES ON WHICH HIGHER DEGREES WERE AWARDED IN THE FACULTIES OF AGRICULTURE OF AUSTRALIAN UNIVERSITIES

1950 — 1956

The Journal intends publishing each year a list giving the titles and authors of theses on which higher degrees in Agriculture were awarded by Australian Universities. It is felt that this annual list will inform readers of research that has been carried out in the Universities and reported in a thesis but not necessarily published elsewhere. To commence these annual lists all higher degrees awarded since 1950 *are listed.*

University of Sydney

1950	D.Sc.Agr.	R. N. McCulloch. Studies in the control of Chiggers.
1951	D.Sc.Agr.	A. R. Woodhill. Studies in the biology and systematics of Australasian mosquitoes.
1952	M.Sc.Agr.	F. W. Hely. Studies with annual species of Medicagos in Australia.
1953	M.Sc.Agr.	Dorothy E. Shaw. Studies on species of *Septoria stagnosostora*, *Selenophoma* and related *Leptosphaeria* on the Gramineae in Australia.
1954	M.Sc.Agr.	G. T. Babriwala. Studies of rust in barleys.
1955	Ph.D.	D. S. Athwal. Genetics of resistance to stem rust (*Puccinia graminis tritici*) and leaf rust (*Puccinia triticina*) of wheat, with particular reference to the identification of genes involved.
	Ph.D.	H. B. Kerr. Studies of the pathogen *Melampsora lini* (Pers.) Lev. in Australia, with particular reference to physiological specialisation, and the genetics of host resistance.
	M.Sc.Agr.	R. A. Daly. Fleece growth in young ewes of four brands.
1956	D.Sc.Agr.	J. M. Vincent. Root nodule bacteria of pasture legumes.
	M.Sc.Agr.	C. I. Davern. The genetic and physiological basis of flowering in subterranean clover (*Trifolium subterraneum* L.).
	M.Sc.Agr.	E. J. Martyn. The ecology of control of Tasmanian pasture insects.
	M.Sc.Agr.	N. S. Snow. A polarographic and turbidimetric investigation of the caseins in cow's milk.
	M.Sc.Agr.	K. J. Hutchinson. Non-heritable factors influencing baconer carcase quality.

University of Melbourne

1950	Ph.D.	P. S. Lang. Survey of the sheep industry in the Western District of Victoria.
1951	Ph.D.	C. R. Millikan. Collected papers dealing with plant nutrition, particularly with regard to trace elements.
1951	M.Agr.Sc.	G. Alexander. A method of bioassay of the oestrogenic activity of subterranean clover (*Trifolium subterraneum*).
	M.Agr.Sc.	F. Skaller. Studies on the assessment of egg production in poultry breeding work.
	M.Agr.Sc.	N. M. Tulloh. Breeds of sheep in the Western District of Victoria—The population, dynamics, replacement systems and breeding methods involved.
1952	M.Agr.Sc.	K. P. J. Barley. A history of two Victorian farmers' organizations: The Royal Agricultural Society and the Chamber of Agriculture.
	M.Agr.Sc.	R. D. Brook. Studies on defoliating fungi of tomatoes and beans.
	M.Agr.Sc.	D. N. Kherdekhar. Dissertation on several topics related to agricultural machinery.
	M.Agr.Sc.	F. Myers. The toxicity of oil herbicides to *Paspalum dilatatum* Poir. with special reference to the effect of composition of the oil.
	M.Agr.Sc.	O. B. Williams. The natural pastures of an area formed by stream influence at Deniliquin, N.S.W., and an account of the factors which determine their distribution.
1953	M.Agr.Sc.	J. G. Bath. Clover-ley farming at the Rutherglen research station.
	M.Agr.Sc.	B. R. Davidson. A survey of portions of the counties of Tambo, Croajingalong and Auckland in South-Eastern Australia.
	M.Agr.Sc.	R. H. Hayman. Studies in fleece rot.
	M.Agr.Sc.	I. Molnar. Collected papers in agricultural economics.
	M.Agr.Sc.	C. W. E. Moore. The vegetation of the South-Eastern Riverina.
	M.Agr.Sc.	G. K. Zende. The effect of air-drying on the level of extractable manganese and cobalt in the soil.

1954	M.Agr.Sc.	V. D. Dhar. A survey of Queen Victoria Market: the Melbourne Wholesale Fruit and Vegetable Market.
	M.Agr.Sc.	W. P. Dunk. Methods for controlling weed growth in Victorian irrigation and drainage systems with particular reference to chemical methods.
	M.Agr.Sc.	B. K. S. Jain. Report No. 1: Study of harvesting operations in the Wimmera. Report No. 2: Visit to the International Harvester's Geelong works. Report No. 3: Study of rice growing techniques in the Murrumbidgee Irrigation Area. Report No. 4: A survey of hourmeters and tachometers for tractors. Report No. 5: Visit to the sugarcane growing regions in Queensland.
	M.Agr.Sc.	Jill B. Naylor. Studies on plant pathogenic bacteria with emphasis on serological classification.
	M.Agr.Sc.	G. A. Stewart. Soils of the Katherine-Darwin Region, Northern Territory.
1955	M.Agr.Sc.	D. E. Harrison. Bacterial wilt of potatoes caused by *Pseudomonas solanacearum* E.F.S., including a comparison of Victorian and other strains of the organism with the Ring Rot Bacterium, *Corynebacterium spendonocum* (Spiek, and Kotth.) Skapt. and Burk.
1956	M.Agr.Sc.	N. W. Moore. Endocrine interactions in the oestrous cycle of domestic animals with particular reference to the sheep.
	M.Agr.Sc.	J. Papadopoulos The effect of the level of nutrition during pregnancy and lactation on the production of grazing sheep, and the interaction between levels of fertility of nutrition.

University of Queensland

1950		———
1951		———
1952	Ph.D.	R. S. Newton Langdon. Studies on ergot.
	M.Agr.Sc.	A. F. B. Common. Studies in the control of Heliothis with D.D.T. in Central Queensland.
1953	M.Sc.Agr.	R. C. Colbran. The distribution, ecology and control of plant parasitic nematodes in Queensland.
	M.Agr.Sc.	A. R. Prasad. Studies on the protection of cereals with insecticidal dust.
1954	Ph.D.	S. K. A. Weerawickrema. The phosphate nutrition of *Paspalum dilatatum* (Pior), *Paspalum commersonii* (Hubbard) and *Trifolium repens* (L) in Beewah Sandy Soil.
	M.Agr.Sc.	Y. P. Beri. A comparison of the toxicity of D.D.T. to different stages of *Pieris rapae* and *Plutella maculipennis*.
	M.Agr.Sc.	S. V. Patil. Nitrogen nutrition of grain sorghum.
1955	Ph.D.	N. G. Dastane. A comparative study of water relations of drought resistant and drought susceptible varieties of sugar cane.
	Ph.D.	M. H. K. Shah. The effect of raised body temperature on the survival rate of fertilised ova and measured by the technique of trans-plantation.
	M.Agr.Sc.	V. R. Smythe. Studies on the effect of transport and storage on the bacteriolgical quality of raw milk.
	M.Agr.Sc.	O. W. Sturgess. Leaf shrivelling virus diseases of the tomato.

University of Adelaide

1950		———
1951	Ph.D.	A. Karim. A study of the major groups of soils as encountered in a portion of the Barossa Valley, South Australia.
	Ph.D.	T. O. Browning. Ecology of the Australian black field cricket (*Gryllulus commodus* Walk.) in South Australia.
	M.Ag.Sc.	P. F. Butler. Part A. The measurement of soil moisture *in situ*. Part B. The study of soil moisture changes under a simple crop rotation.
1952	Ph.D.	K. F. Tejwani. Investigations concerning the cation exchange properties, the behaviour under electrodialysis and the nature of soil acidity of some selected Australian soils with special reference to the type of clay mineral characterizing them.
	M.Ag.Sc.	J. A. Zwar. Studies on the absorption of 2,4:Dichlorophenoxyacetic acid.
1953	Ph.D.	H. K. Saksena. (The) Activity of and the factors affecting the prevalence of some soil fungi pathogenic to plants.
	M.Ag.Sc.	P. E. Madge. Studies on certain injurious Australian insects.
	M.Ag.Sc.	M. B. Spurling. The water requirements of citrus with special reference to citrus leaf drop.
1954	Ph.D.	J. S. Kanwar. Availability of phosphorus and copper in some Australian soils, with special reference to the Seddon series of Kangaroo Island.
	M.Ag.Sc.	N. S. H. Ambastha. (Part I) A comparative study of genes for resistance to bunt (*Tilletia caries* (D.C.) *Tal.* and *T. foetida* (Wallr.) (Liro) of wheat. (Part II) Cytological investigations in Phalaris.

1955	Ph.D.	A. S. ATWAL. Ecological studies on the diamond-back moth (*Plutella maculipennis* Curtis) and its parasites.
1956	Ph.D.	A. KERR. Studies on the parasitic and saprophytic activities of *Pellicularia filamentosa* (Pat.) Rogers and *Sclerotinia homeocarpa* Bennett.
	Ph.D.	P. E. MADGE. The distribution and abundance of micro populations of *Oncopera fasciculata* in South Australia.
	M.Sc.	K. KANDASAMY. Comparative effects of nitrogen, phosphorus and the micronutrients on rice and oats on a lateritic soil.
	M.Ag.Sc.	J. L. DAVIDSON. The influence of defoliation on the growth of subterranean clover (*Trifolium subterraneum* L.).
	M.Ag.Sc.	A. J. JEEVARATNAM. Studies on the nitrogen cycle under systems of crop rotation.
	M.Ag.Sc.	J. LOVEDAY. Soils of the Sorell-Carlton-Copping area of County Pembroke, Tasmania, with special reference to soils formed on basalt.

University of Western Australia

1950	M.Sc.(Agric.)	R. C. ROSSITER. Studies on perennial veldt grass (*Ehrharta calycina* Sm.).
1951	Ph.D.	JUNE EAST. The oestrogenic effects of subterranean clover in the guinea-pig.
	M.Sc.(Agric.)	V. J. WILLIAMS. The influence of nitrogen from different sources upon the nitrogen metabolism and micro-organisms of the rumen of growing lambs.
1952	D.Sc.(Agric.)	R. SMITH. Soils of the South Western Australian agricultural region.
	D.Sc.(Agric.)	R. C. ROSSITER. The nutrition of pasture plants in the south-west of Western Australia, with particular reference to subterranean clover (*Trifolium subterraneum* L.).
1953	Ph.D.	K. W. FINLAY. Some genetic aspects of resistance to the spotted wilt virus in tomatoes and their practical application in plant breeding.
1954	M.Sc.(Agric.)	E. R. WATSON. A critical review of cereal breeding for disease resistance in Australia.
	M.Sc.(Agric.)	I. P. BARRETT-LENNARD. A study of gains and losses of soil nitrogen in Western Australian wheat-belt soils.
	M.Sc.(Agric.)	R. O. SLATYER. Studies in tropical crop production: the Katherine (Northern Territory) environment and its influence on crops of cotton, peanuts and grain sorghum.
1955	Ph.D.	D. P. DROVER. Studies of the fertility of some coarse textured soils of Western Australia, with particular reference to factors influencing their organic carbon and nitrogen contents.
	Ph.D.	RHONA GILES. A study of some factors influencing protein utilisation.
	M.Sc.(Agric.)	D. P. FISCHER. A survey of acceptance of farm practices together with an appraisal of agricultural extension, in the wheatbelt of Western Australia.
	D.Sc.(Agric.)	A. J. MILLINGTON. A study of some aspects of Australian wheat production.
1956	D.Sc.(Agric.)	A. J. ANDERSON. The role of molybdenum and other elements in plant nutrition.
	Ph.D.	H. P. SCHAPPER. A survey of sheep and wheat farming in the eastern wheatbelt of Western Australia.
	M.Sc.(Agric.)	E. N. FITZPATRICK. An investigation into the problems of establishment and nutrition of subterranean clover on some acid and peaty soils.
	M.Sc.(Agric.)	C. T. GATES. The response of the young tomato plant to a brief period of water shortage.
	M.Sc.(Agric.)	M. C. NOTTLE. Changes in the concentration of rumen bacteria in sheep fed a single diet.

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TALKS

The History and Development of the Faculty of Agriculture, University of Queensland

Professor L. J. H. Teakle, Dean of the Faculty of Agriculture, Queensland University, in a Presidential address to the Queensland Branch.

There are three main dates in the history leading to the foundation of the Faculty of Agriculture in the University of Queensland—

1859—the foundation of the State of Queensland;
1909—the foundation of the University;
1926—the foundation of the Faculty of Agriculture.

The University was founded with three Faculties—Arts, Science and Engineering—and the early hopes of those pioneers working for the establishment of the University that Agriculture and Veterinary Science would be recognised were not realised.

The Governor, *Sir William MacGregor*, expressed this disappointment in his inaugural address as first Chancellor of the University when he said:

"A Chair of Agriculture and a Veterinary Chair are already pressing necessities."

The reply of Premier Denham on the same occasion was that "the means should come from private munificence."

For 26 years, there was a campaign for the establishment of the Faculty, the drive coming almost entirely from outside the academic forces of the University.

Mr. Robert Christison, in 1910, gave £1,000 toward the establishment of a Chair of Tropical and Semi-Tropical Agriculture. To further this ambition, he organised a committee in London to raise money for the establishment of the Faculty, but his efforts were disappointing and only £3.276/11/- was subscribed by the end of 1914, when war conditions ended the appeal.

During the same period, a memorial fund of £1,366 to *Sir Robert Philp* was established to be held in trust for the Faculty of Agriculture, when founded.

In 1916, *Mr. J. D. Story* commenced his campaign to organise agricultural education from the primary school to the University. Over the next eight years, several proposals were considered by the Senate: The first was a degree course; then a licentiate. The idea of a degree was again revived, but it, too, failed through lack of funds. In 1923, a diploma was suggested, but the idea met a similar fate. It is of interest that, during this period, the University staff generally was either not interested or in opposition to Agricultural Science as a University discipline. Only the Senate and public bodies such as Chambers of Commerce, Agricultural Societies, the Council of Agriculture, the C.O.D. and sugar producers supported the cause.

The movement was accelerated in 1924, when *Professor E. J. Goddard* became convinced that a Faculty of Agriculture was needed. Speaking to the Council of Agriculture, he made a strong plea for its establishment because, he said: "Science Departments turn out laboratory men trained in a speciality but ignorant of agriculture itself.' The proposal found favour and, led by *Mr. Story*, the Senate resolved in 1925 and again in 1926, to establish the Faculty. Implementation was prevented by lack of funds until, in December, 1926, the *Honourable W. Forgan-Smith*, Minister for Agriculture, was convinced, and announced that the Cabinet had allocated £5,000 for the establishment of the Faculty, and publicly stated that he was "all impatience to get to work."

The first Faculty Board met in January, 1927, and was strongly supported by the Department of Agriculture and Stock. Teaching started in March, 1927, with ten students, eight in first year and two in second year. The Principal of Gatton Agricultural College, *Professor J. K. Murray*, was appointed Honorary Professor, and in 1928 *Mr. F. A. Perkins* and *Mr. H. J. G. Hines* were appointed full-time staff members.

At first, the four-year curriculum was based largely on 'borrowed' courses from Science, Commerce, Engineering, and from Gatton Agricultural College.

Gatton diploma-holders were allowed a concession of one year and other students attended the College for one year as part of their training. The course was designed to cover the full range of agricultural science.

Six years later, specialisation was introduced, beginning in third year, three courses being offered—

(a) General Agriculture;
(b) Animal Nutrition and Dairy Manufactures;
(c) Applied Botany, Entomology and Soils.

This experiment lasted only two years and the Faculty reverted to the principle of the old course. Specialisation was revoked because it interfered with the balance and perspective of the course.

This left unsolved the problem of preparing students for special services. The curriculum was designed to train a general practitioner and did not meet the needs of specialists. This need was met in 1938 by providing an extra year's training for students proceeding to Honours. This idea has been retained and has proved satisfactory.

In 1955, a degree of specialisation was again introduced, this time limited to about one-quarter of the student's time in fourth year. The course now provides the basic training necessary for Agricultural Science, and sufficient specialisation to introduce students to future work for Honours or higher degrees should they desire to continue their studies.

The Master's degree was instituted in 1934 and the Doctorate in 1936.

Throughout its history, the Faculty has enjoyed a close association with the Gatton Agricultural College and has relied very largely on the College for training in such applied subjects as Agricultural Practice, Horticulture and Animal Science. At first, University students took much of their training at the College with diploma students, but during the last ten years special courses, better adjusted to University standards, have been improved. The College staff is strengthening, and, with the fine farming lands and modern machinery, the work at the College is a very valuable part of the curriculum.

A number of generous citizens have endowed the Faculty. Mention has been made of the *Christison Fund* and the *Robert Philp Memorial Fund* established shortly after the University was founded. Other important benefactions include the *Forsyth Bequest* of £5,000, the *William Robertson Bequest* of £19,400, the *Edwin Munro Bequest* of £2,500, and £1,000 from *Sir Edwin Tooth*, to be used for erecting a plant house at St. Lucia.

In 1956, the Queensland Acclimatisation Society gave the University its farm at Redland Bay and securities valued at over £10,000. This valuable property is to be used for teaching and research work in Agriculture and Applied Botany.

In all, these benefactions are valued at about £60,000.

In 1946, the *William Robertson Chair in Agriculture* was established and the first full-time Professor appointed in 1947.

With the establishment of the Chair, the research programme in the Faculty was extended and has since grown very substantially. Within the Department of Agriculture itself, the permanent staff now numbers four, and there are three research officers supported by special research funds. One research project is a study of soil fertility on the Darling Downs, directed to an examination of soil moisture conservation and utilisation, the availability of nitrogen in relation to crop yield and quality, and changes in soil structure with cultivation. Another is an investigation of the prospects for opportunist farming in the sheep areas of western Queensland for fodder conservation as a means of drought mitigation. Work in the Department of Entomology includes the investigation of the fruit fly, mosquito control and the systematics and biology of Australasian Hemiptera. In Agricultural Chemistry, the chemical properties of the starch fraction of wheat have been investigated.

This research programme has been made possible by grants from various sources, chief of which are the Rural Credits Development Fund of the Commonwealth Bank, now totalling over £15,000; the Queensland Grain Growers' Association, graziers, pastoral companies, banks and machinery firms, whose contributions exceed £8,000; and income from the *Lewis and Grace Bond Bequest* of £15,000.

In the thirty years 139 students have received Bachelors degrees. Of these, 46 have been awarded Honours, some 21 have taken the Master's degree, and 2 the degree of Doctor of Agricultural Science.

The graduates have found employment in many fields. Most are with Government agencies. In the Queensland State Government and Sugar Bureau, there are 52; in the Commonwealth Government, 24; Australian Universities, 7. Eleven graduates are in professional service with private companies; 10 are engaged in farming and grazing enterprise.

The future looks sound. In the Faculty, there are now 113 students; 91 of them are full-time students in Agriculture; 18 in Forestry; and 4 are registered as miscellaneous students, taking special courses.

In the future, the course can be expected to maintain its foundation on the basic sciences, especially Botany, Chemistry and Soil Science. Certain "borrowed" courses still persist in the curriculum and will need to be replaced by properly adjusted syllabuses as staff becomes available. The scope for an introduction to specialisation in fourth year will be extended. At present, specialisation is provided for Agricultural Practice and Extension work, Agricultural Chemistry and Soils, Entomology, Plant Pathology and Genetics and Plant Breeding. As the Faculty develops, other subjects should be offered. The first, may I suggest, should be Farm Management—the study of the economics of the various operations in the farming enterprise, and the marketing of the agricultural product. Others are Agrostology, Horticulture, Animal Husbandry and Animal Nutrition. The present organisation of the curriculum is elastic and can be adjusted to any future needs.

Post-graduate training must be strengthened and opportunities provided for higher studies in many fields. Courses in Science, Veterinary Science, Commerce and Social Science may be used to strengthen the basic training of graduate students and to form the basis for research projects.

The continuing objective will be the balanced agricultural scientist:—

- understanding crops and stock in their physical environment;
- understanding the farmer in his economic and social environment;
- knowing the techniques for improved farm management.

For the Faculty of Agriculture, there is a great responsibility and unparalleled opportunity for service.

The United States Soil Conservation Service

Mr. W. R. van Dersal, Deputy Administrator, U.S. Soil Conservation Service.

Mr. van Dersal described the method by which the S.C.S. encourages farmers and ranchers to employ soil and water conservation practices. The S.C.S. encourages the local people to do the work with technical assistance from S.C.S. conservationists.

All the States and Territories have passed legislation for the setting up of soil conservation districts. Since 1938, 2,750 of these districts have been set up and they now include 87% of farm and ranch lands and involve 91% of farmers and

ranchers in U.S.A. The areas of the districts vary from 7,000 to 5,000,000 acres while the numbers of farmers in the districts range from 13 to 17,000. Districts are still being set up and it is expected that in the next few years the whole country will be included.

When it is decided to set up a soil conservation district a district governing body, usually of five members, is formed. All the members are local farmers; three are elected by the local people and two are appointed by the State. The district governing body frames a long term programme of work for the district. The S.C.S. then provides a technical advisory body called a work unit. The work unit is led by a soil conservationist, usually a college graduate, whose team consists of a soil surveyor, an engineer and, if warranted, a range specialist, a forester, an agronomist or a biologist.

The S.C.S. suggests to the district governing bodies that conservation plans should be applied to properties as complete units and that the plans should be based on soil surveys.

The S.C.S. work unit begins by making soil surveys of the various properties in the district. As each farm is surveyed, the work unit conservationist looks over the property with the owner and discusses with him the alternative methods of land use which could be successfully adopted, advising him regarding the necessary conservation measures. The final decision on the method of land use is made by the farmer.

The farmer and the conservationist then work out a farm plan which is to be applied over a period of years. The farmer signs a contract with the district governing body which agrees to provide assistance to put the plan into effect. Heavy machinery is usually made available by the district body. Only 5% of the money spent is provided by the states, the remainder of costs being borne by the local people.

The S.C.S. is convinced that, though the rate of getting the work done is slower, far better results are obtained if the request for work comes from the local people.

Selective Weedicides

Presidential address to S.A. Branch by Mr. A. J. K. Walker, Chief Agricultural Adviser, Department of Agriculture.

Pointing out that chemical weedicides were becoming increasingly popular with the lack of suitable biological controls, Mr. Walker traced the development of weedicides and the search of selectivity over the past 60 years.

1. *Contact Weedicides.*
   (1) Salts and Acids—
   Ferrous Sulphate.
   Copper Sulphate.
   Sulphuric Acid.

These substances were used on cruciferous weeds in cereals right up to 1944. Their selectivity due to plant structure and habit differences, is useful, but they have disadvantages in application and are affected by rain.

(2) Di-nitro-phenols—

(a) Sodium di nitro ortho cresolate (DINOC)—

DINOC is selective on cereals and flax and more convenient and quicker penetrating, especially as the ammonium salt, than the salts and acids.

(b) Sodium di nitro ortho secondary butyl phenol (DINOSEB)—

DINOSEB is very toxic but can be used on legumes and the amine salt is very active on roots of young seedlings. As a pre-emergence spray it is selective because it remains in the surface soil and does not affect deeper planted crop seeds.

(3) Oils—

Light oils are very selective but have a high flash point. Heavy oils are not as selective and produce flavour and odour effects.

These have a narrow range only.

2. *Translocated Weedicides.*

It was pointed out that the greatest step in weedicide development was the discovery (1940) of translocated weedicides.

(1) 2 methyl. 4 chloro phenoxy acetic acid (M.C.P.A.) 2,4,di-chloro phenoxy acetic acid (2,4,D)—

These have a wide range of toxicity among broad leaved plants. They show great selectivity between species as well as canopy effects. Translocation allows incomplete wetting of the plant and has led to the introduction of low pressure sprays.

There has been a wide search among the salts of these compounds. Some specific sprays such as 2,4,5,T on brigalow and blackberry, have been produced.

(2) Phenyl carbamates—

In the search for suitable weedicides for narrow leaved grasses, unaffected by 2,4,D, such compounds as Iso-propyl phenyl carbamate (I.P.C.) were tested. I.P.C. is only useful on annual grasses and is only absorbed by the roots.

(3) Trichlor acetic acid (T.C.A.)—

This also is only taken up by the roots. It is quickly leached and broken down in the soil.

(4) Substituted Ureas (C.M.U.)—

Para chlor phenol di-meltryl urea is the most common. It is of little use on perennials but is highly selective, particularly on row crops.

(5) Di-chloro propionic acid (DALAPON)—

This is translocated often from foliage as well as roots but it has a short residual effect and therefore can never be used at high rates. It allows control of perennials but not eradication.

(6) Butyric Acid substituted M.C.P.A. and 2,4,D—

M.C.P.B.
2,4,D.B.

Work at Wye College, London (1954) has shown that when butyric acid is substituted for acetic acid the resulting compounds are doubly selective. When 2,4,D.B. is absorbed enzyme systems

break it down to 2,4.D. Some plants lack the required enzymes. This opens the field of very early removal of competing weeds in crops.

(7) Substituted Acetamides—
C.D.A.A.
C.D.E.A.
These are pre-emergence sprays to which some crops show true resistance. They are highly selective, wild oats being killed in barley.

Mr. Walker concluded by stressing that:—

1. A great deal of fundamental work is needed on mode of action, etc., to give a sounder basis.
2. In South Australia we must test fully the butyric acid substitutes of M.C.P.A. and 2,4,D, and Dalapon; in particular, on deteriorating pasture where a seed bed cannot be prepared.
3. We must endeavour to fit weedicides into our long term farm management.

Weather and Plant Disease

Mr. B. Mason, Climatologist, S.A. Meteorological Bureau

Atmospheric turbulence is of basic importance in the spread of fungus disease spores. Turbulence in a moving medium is characterised by the occurrence of eddies which may vary in size from a micron up to thousands of miles in diameter. Atmospheric turbulence causes the air mass to break up into cells which are responsible for the characteristic gusts and lulls of wind movement.

There are three main factors to be considered in the spread of disease.

1. *Escape of spores into the atmosphere.*

Energy must be supplied. This may be done by the fungus itself, by insects, or by rain drop action. Rain drop energy may initiate the discharge of spores from the organism, or rain drop splash may carry spores high enough into the air for their escape.

2. *Dispersion of spores.*

Turbulence is the dominant factor in dispersion of spores by the atmosphere. Spore sizes vary approximately from 5 microns to 20 microns. Their rate of settling is very slow. Winds of only 2 m.p.h. provide enough turbulence to keep spores airborne against gravity. Movement in large eddies may take spores to great heights and hence over great distances. However, tests indicate that by far the greater majority of spores are carried only short distances.

3. *Deposition of spores.*
   (a) *Impaction.*—There is a cushioning action and spores tend to be carried around obstacles to some extent, rather than impacting on them.
   (b) *Sedimentation.* — Gravity effects are negligible except at night when wind velocities may be less than 2 m.p.h. High humidity speeds the rate of sedimentation.
   (c) *Boundary layer exchange.*—Movement of spores into the "dead-air" skin surrounding objects.
   (d) *Turbulent deposition.* Rate of deposition by this means varies almost directly as wind speed. At 15 m.p.h. there is equal deposition of spores on the top and bottom surfaces of leaves.
3. *Rain washing.*

Spores are very readily collected from the atmosphere and carried to earth by falling rain drops.

Southern Rhodesia and some aspects of its agriculture

Mr. H. D. L. Corby, Grasslands Research Station, Marandellas, Southern Rhodesia, in a talk to the Queensland Branch

Southern Rhodesia is part of the recently formed Federation of Rhodesia and Nyasaland, the other two members being Northern Rhodesia and Nyasaland.

The Federation lies well south of the Equator, but well north of the Tropic of Capricorn, and is therefore entirely tropical in latitude. Climate, however, is relatively cool as most areas are well over 3,000 ft. above sea level.

The Federation extends over about half a million square miles—about one-sixth the size of Australia; about three-quarters the size of Queensland. Total population is a little over seven million—about threequarters that of Australia—so density of population is a good deal greater than that of Australia. About 96 per cent. of the population is African, about 3½ per cent. European, and the remaining ½ per cent. Indian or of mixed race. This means that the ratio of Europeans to non-Europeans is about 1 : 30.

Most of the wealth of the Federation comes from mining, and most of the mining wealth from copper, of which nearly half a million tons a year is produced, is in Northern Rhodesia. Tobacco is also of great importance, production having reached 85,000 tons a year, mainly from Southern Rhodesia. Tea is the most important product of Nyasaland, to the tune of 7,000 tons a year. A very large hydroelectric scheme is now being built on the Zambesi River, with an estimated capacity of 1,200 megawatts, for the use of industry.

Confining attention now to Southern Rhodesia, African farmers grow maize, sorghum, millets and pulses, and keep cattle, sheep and goats, and farm mainly at subsistence level. European farmers, on the other hand, generally operate on a large scale, growing maize and tobacco in the wetter areas and ranching with cattle in the drier areas. Comparatively small areas of cotton, tea and sugar are grown. There are two distinct seasons: a wet and a dry, with most of the rain falling between November and March, and practically none from June to September. Along the eastern border rainfall may be more than 50" a year, but, broadly speaking, gets less and less to the south and west decreasing to less than 15" a year.

Official relations with farming communities are effected mainly through the "Intensive Conservation Area" system. At farmers' own re-

quest, a small natural region is declared on I.C.A., a committee of farmers is appointed, and a member of the Department of Conservation and Extension is attached. Committees organise contouring, dam-making, field days, visits to research stations, etc. A parallel system is being developed in African farming areas.

There are three main regional research stations: one at Matopos to serve the lower rainfall areas, and two to serve the higher rainfall regions, one of these being at Mazoe to serve the red soils, and one at Marandellas to serve the sandy soils. There are also a number of smaller stations for special purposes.

Confining attention to the station at Marandellas and to the region it serves, soils are very sandy, derived from granite, are easily worked but of very low fertility. It is on such soil that tobacco is grown because of the relative ease of controlling the nitrogen supply. By the same token, however, other crops have been little grown hitherto.

The main problem with such soils is to maintain fertility, and the Marandellas station is concentrating on developing a system of ley farming in the hope of maintaining it in that way. All indications are that it will work.

Good progress has been made with selection of grasses and with finding strains that will seed well, to replace those that have to be planted by root, and cultural requirements of grasses are now fairly well understood. Progress with legumes has been poor, mainly it is thought because insufficient attention has been given to their nutritional and bacterial requirements. With arable crops attention has been confined to maize, with which good progress has been made. The requirements of conservation management of natural grassland are now fairly clear, but very little progress has been made in the "vlei' land. For provision of winter feed attention is now confined mainly to silage, foggage and irrigation. With animals, effort is mainly devoted to relating dairy cattle, beef cattle and sheep to the ley farming scheme.

APPOINTMENTS AVAILABLE — *See also pages 137, 143, 148, 179, vii.*

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Further information and the conditions of appointment may be obtained from the undersigned with whom applications will close on 31st July, 1957.

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NEWS ITEMS

N.S.W. Department of Agriculture

In accordance with the policy of decentralising administration and control of agricultural extension services, the N.S.W. Department of Agriculture has established its sixth Agricultural Region, the Northern Region, with headquarters at Tamworth. The Regions already operating successfully, and their headquarters, are the Southern (Wagga), North Coast (Lismore), Western (Orange), South Coast and Tablelands (Goulburn) and South Western (Leeton).

The Northern Region was inaugurated on 14th February, 1957, and notice has been given that the seventh Region, the Mid-Coast and Hunter, with headquarters at Maitland, will be established in June 1957.

Within each Region the advisory services are administered by a Regional Supervisor and a Regional Advisory Committee of practical farmers is appointed to consider plans for the promotion of agriculture.

It is anticipated that the whole of the agricultural areas of N.S.W. will be divided into Regions by the end of 1958.

M.I.A. Fruit Tree Census

A further census of the nearly 2 million fruit trees and vines on the M.I.A. is being conducted by the Irrigation Research and Extension Committee in conjunction with the N.S.W. Department of Agriculture, Rural Bank and Irrigation Commission. Apart from the actual census of trees present, a survey is being conducted to determine the extent of tree mortality caused by recent wet seasons and the health and productivity of remaining trees and vines. The aerial survey has been completed and the tree-to-tree survey is in progress.

The estimates of tree losses as at the commencement of this year, go as high as 300,000.

The first M.I.A. census was carried out in 1942 following an aerial survey in 1940. This census has been revised periodically and an aerial survey was repeated in 1950. The results of the present census are considered vital to future farm and industry planning.

Concentrate Spraying of Fruit Trees

Two new machines which apply sprays in a 100 per cent. concentrate form are being tested by the N.S.W. Department of Agriculture in the Batlow apple district. The two machines, called the "Iden" and the "Micron-Meg", are similar in principle and have been used to apply a programme of 100 per cent. lime-sulphur for Black Spot control. Neither machine has given quite the control obtained with conventional machines, however, this does not mean that they are unsuitable but that a modified spraying technique is required. The machines appear to generate insufficient blast to provide complete coverage when operated in anything more than a 5 miles per hour breeze, and must therefore be used only under calm conditions such as early morning or late afternoon.

Bread Quality

Recent investigations at Wagga Agricultural Research Institute have led to findings which could be of the utmost significance to the programme of breeding better quality wheats. It appears that certain starch characteristics can be just as important as the much publicised protein in producing quality bread and that some of the present varieties of wheat do not appear to have these two factors satisfactorily balanced.

Efforts will now be made to apply the information in evolving more effective tests on small samples of wheat to assist Plant Breeders in making their early selection of new varieties.

Tomato Hybrids

Yield increases of up to 66 per cent. and averaging 30 per cent. have been obtained from new tomato hybrids tested by the Department of Agriculture, and three of the hybrids can now be recommended to growers.

The hybrids recommended are Break O'Day x Rouge de Marmande Fl. (with Break O'Day as female parent); Grosse Lisse x Rouge de Marmande Fl. (with Grosse Lisse as female parent); Grosse Lisse x Valiant Fl. (either parent as female).

Break O'Day x Rouge de Marmande Fl. can be strongly recommended as a first early spring or early summer crop, and for use in the glasshouse industry. It produces average sized fruit, smooth to slightly corrugated in shape.

When compared with Rouge de Marmande, its average yearly increase in yield over the past five years was 59 per cent. and the total increase during the period averaged 35 per cent.

Grosse Lisse x Rouge de Marmande can be recommended for use in the Metropolitan and Central Coast areas as an early cropper.

This hybrid has been shown to be six to seven days earlier than Grosse Lisse. It has a slightly smaller, but good, smooth fruit.

Over the past five years it has given 47 per cent. increase in yield over Rouge de Marmande in the first twenty-eight days of picking, with a total increase over the cropping period of 29 per cent.

Grosse Lisse x Valiant Fl. has shown particular promise and should be suitable for all tomato growing districts as a main crop.

During the last five years it has given 31 per cent. increase in yield over Grosse Lisse and in the first twenty-eight picking days the average increase in yield was 38 per cent.

Testing of the new tomato hybrids began at Hawkesbury Agricultural College in 1950. The project was initiated by agronomist, Mr. E. J. Waring, and for the last five years has been carried out under the supervision of agronomist, Dr. R. Gottl.

International Conference on Scientific Documentation

For almost one year a small Planning Committee has ben considering possible plans for an International Conference on Scientific Information.

On November 11 last the sponsors of the proposed Conference, namely the National Academy of Sciences, the National Science Foundation and the American Documentation Institute, called together under the Chairmanship of Dr. Warren Weaver some 55 eminent scientists, industrialists and documentalists, with the members of the Planning Committee.

Members of the Committee outlined the plans which they had considered as desirable for the forthcoming Conference, the time for which was suggested as November, 1958. Seven working areas were proposed, the underlying theme for them all being the storage and retrieval of information. First was to be a study of demand —the requirements of scientists for scientific literature and reference services, the knowledge now available, and methods for ascertaining the requirements of scientists. Following this was to be a study of present ways and means covering three sections broadly grouped as abstracting and information services, monographs, compendia and specialised information centres, and finally the status, development and comparative characteristics of present systems of machine storage and retrieval.

In the terms of new systems an area will be given over to a basic study of the organisation of knowledge for storage and retrospective search and the intellectual problems and equipment considerations which arise in the design of new systems—in other words, can the user of scientific information more adequately brief the designers of modern electronic equipment? Following closely on this and, of course, related to it is the possibility of developing a general theory of storage and search. Finally, arising from the preceding and bearing in mind the rapid increase in scientific and technological knowledge throughout the world, a session is being provided to study and discuss the responsibilities of governmental bodies, professional societies, universities, research and industrial organisations, etc., not only from the point of view of providing the information services but also for the promotion of research in the documentation required.

The Conference endorsed the subjected areas presented, suggesting however that most emphasis should be placed on the study of new systems.

The Conference approved also the general proposals for procedure and it is now expected that a special Committee will be set up by the sponsoring bodies to develop and run the 1958 Conference. Special funds are to be sought to ensure suitable representation and Dr. King, on behalf of U.N.E.S.C.O. and F.I.D. offered to assist in any way possible.

All requests for further information about this Conference should be addressed to the Executive Secretary, Dr. Alberto F. Thompson, International Conference on Scientific Information, National Academy of Sciences-National Research Council, 2101 Constitution Avenue, Washington 25, D.C.

American Gift Aids C.S.I.R.O.'s Drug Research

A prominent American firm has given the C.S.I.R.O. Division of Industrial Chemistry £1,000 to assist its search for new drugs from Australian plants.

The gift from the pharmaceutical firm of Smith, Kline & French Laboratories recognises the work of the Division in its investigations of the native plants of Australia and New Guinea.

The money is to be devoted specifically towards the cost of the vital preliminary phase of the work—the supply of authentic specimens of the required plants, the collection of which involves skilled and arduous work and requires an expert knowledge both of the plants and of the areas—often wild and remote—in which they may be found.

Smith, Kline & French Laboratories are collaborating with C.S.I.R.O. in this project. Chemical phases of the work are being carried out in the Fishermen's Bend Laboratories of the Division of Industrial Chemistry and pharmacological testing at Philadelphia, U.S.A.

This collaboration will extend the programme initiated some years ago by C.S.I.R.O. with the objects of stimulating the exploitation of Australia's natural resources and assisting in the development of the pharmaceutical industry.

Australia is already deriving a substantial income from its native plants and it is expected that the present programme should reveal new species of commercial importance and also extend the range of drugs available for medical purposes.

Successful Test of Mansfield Process

The successful application of the Mansfield process in reducing evaporation from Stephen's Creek reservoir at Broken Hill gives some indication of the potential value of this process. During a fourteen weeks test evaporation was reduced by thirty-seven per cent.

From this experiment the estimated cost of the water saved is one penny per thousand gallons. Under less favourable conditions the cost of saving water will be greater but it should not exceed 6d. per thousand gallons. This is a small cost in comparison with alternative means of obtaining and conserving water.

C.S.I.R.O. and the Broken Hill Water Board started a joint research programme in December 1955, under the supervision of the inventor of the process, Mr. W. W. Mansfield of C.S.I.R.O.'s Division of Industrial Chemistry. The object was to modify the process to work on large areas of water. The raft method, which is being used extensively now on small areas of water, is uneconomic on large areas because of difficulties associated with the action of wind and wave. However, by December 1956 an alternative method had been found which produced a satisfactory film of cetyl alcohol by feeding on to the surface of the reservoir a solution of cetyl alcohol in a solvent.

With this new method a satisfactory film has now been maintained for more than 3 months in spite of exceptionally high wind velocities. About one foot of evaporation has been saved over an average area of 930 acres.

Some further difficulties may be encountered in applying the process to the largest water storages, but the present results suggest that these difficulties will be overcome as a result of further research now in progress.

Nuffield Foundation Australian Advisory Committee

Grant to Professor C. W. Emmens, Department of Veterinary Physiology, University of Sydney.

The Chairman of the Nuffield Foundation Australian Advisory Committee, Mr. Colin Syme, has announced that the Nuffield Foundation has made a grant of £1,400 a year for three years to Professor C. W. Emmens, Professor of Veterinary Physiology at the University of Sydney, for work relating to the storage of semen. The particular project will be the comparative study of the chemistry of bull, ram, rabbit and human semen, with special reference to the metabolism of spermatoza and factors affecting their survival.

These are fundamental studies which are linked with other work in the Department of a directly practical nature. They are the groundwork necessary for further advances in the expansion of artificial insemination in cattle and sheep, and for further developments of the storage of semen for such work by deep-freezing or other promising methods.

New Service For Banks

The establishment of a Rural Research and Liaison Service by the Commonwealth Bank of Australia is a recent development of interest to agricultural scientists. This includes a service which the Central Bank has made available to all Australian banks. Essentially, the function of the new Service is to act in a liaison capacity between the banks, and organisations such as C.S.I.R.O. and the Departments of Agriculture.

One of the general aims of the Rural Liaison Service will be to assist Banks in directing their efforts to promote rural development in a more effective way. Information will be provided about areas where development is taking place and about the particular problems of development caused by weeds, pests and diseases or limitations due to soil and rainfall. The importance of new agricultural techniques as they affect banking will be particularly studied and emphasis given to the business side of farming. A major part of the work of the Service will be to supply information on the market outlook for various commodities.

Initially, the Service will operate on a modest scale but it could grow considerably, depending on the extent to which banks find they can make use of it. It is expected that its main service will be to answer specific inquiries put to it by the banks. In addition, it will prepare digests, organise study tours by bank managers and participate in various other activities which will help to provide more effective banking services to the rural community.

The headquarters of the Service are in Sydney and in addition, the Service has an office in Melbourne.

The Service is being developed under the general supervision of *Mr. I. A. Butler, Mr. A. J. McIntyre* is Chief Officer and the Liaison Officer in Melbourne is *Mr. D. G. McKenna. Mr. R. W. Prunster,* who has been Principal Research Officer in charge of the C.S.I.R.O. Regional Pastoral Laboratory at Deniliquin has been seconded to the Service for a period to help initiate some aspects of its work.

Conference of Agricultural Economists. 20th and 21st February, 1957

A highly successful meeting of Australian agricultural economists was held in Sydney on 20th and 21st February, 1957. It was attended by 125 persons drawn from all the Australian States and New Zealand.

The following papers were presented and discussed at the conference sessions:—

J. G. Crawford: Australian Agriculture and the Balance of Payments.
H. P. Schapper: Uses and Limitations of Farm Surveys.
F. G. Jarrett: Resource Productivities and Production Functions.
T. H. Strong: Quality in Relation to the Marketing of Australian Primary Products.
F. H. Gruen: Capital Formation in Australian Agriculture.

The first afternoon of the meeting was given over to a symposium on "Contemporary Agricultural Economics in Australia and Possible Lines of Future Development," at which the opening papers were presented by K. O. Campbell and D. B. Williams.

The conference decided to form an Australian Agricultural Economics Society and elected the following office-bearers for 1957:—

President: *K. O. Campbell.*
Vice-President: *D. B. Williams.*
Hon. Secretary: *C. P. Dowsett.*
Hon. Treasurer: *F. H. Gruen.*
Members of Council—N.S.W.: *I. A. Butler;* Queensland: *C. H. P. Defries;* A.C.T.: *D. R. Munro;* Victoria: *R. B. McMillan;* Tasmania: *G. Inglis;* South Australia: *F. G. Jarrett;* Western Australia: *H. P. Schapper.*

Membership of the new Society is open to all those interested in agricultural economics and no professional qualifications are required. Enquiries regarding membership should be directed to the Hon. Secretary, Mr. C. P. Dowsett, Rural Bank of N.S.W., Martin Place, Sydney, or the State Councillors. The subscription for 1957 has been fixed at £1. It is anticipated that the proceedings of the February Conference will be available for distribution by August.

It is planned to hold the next conference of the Society in Canberra in February, 1958.

Plant Collection

Mr. D. E. Symon, Agricultural Botanist at the Waite Institute in Adelaide has recently returned from a plant collecting trip in the Mediterranean. During 1956 he visited Italy, Sicily, Crete and Yugoslavia to collect some 1,500 packets of seed.

Among plants collected were relatives of cocksfoot, to help with the breeding programme under way on this plant at the Waite Institute.

He also collected medics and clovers. Among the most promising of these is a perennial which buries its seed, Trifolium uniflorum. It seems to stand up to close grazing well.

One barley variety brought back may help the new barley research programme. It has a stronger straw than that of current commercial varieties.

Victorian Branch Refresher School

The Victorian Branch of the Institute of Agricultural Science is organising a Refresher School to be held at the School of Horticulture, Burnley Gardens, Melbourne during the period 2nd-5th September.

The four day school will deal with the basic sciences of Agriculture relating to the growth of plants. Lecturers will review recent developments in their particular subject, enabling those who attend to obtain an up to date picture of present knowledge in the whole field of plant development and growth.

There will be four lectures on each of the first three days and three on the last day. Each lecture will be of forty-five minutes duration with thirty minutes for discussion.

All Victorian members will be circularised concerning details of the school. Members in other states will be able to obtain full details of the school from their respective Branch secretaries.

The programme for the school is set out hereunder. In one or two instances titles have not been finalised at the time of going to press, but a general indication of the subject is given. The programme as set out here is substantially correct, but some minor alterations as to titles and times may be necessary.

The times at which lectures will commence each day will be 9.30 a.m., 11.15 a.m., 2 p.m. and 3.45 p.m., and they will be given in the order shown below.

MONDAY, 2nd SEPTEMBER

1. "Cell structure and function"
2. "Transpiration" —*Prof. J. S. Turner*
3. "Photoperiodism" —*Dr. D. J. Carr.*
4. "The Rhizosphere concept" —*Dr. A. D. Rovira*

TUESDAY, 3rd SEPTEMBER.

1. "Antagonisms and acidity as effects in the choice of fertilisers"
   —*Assoc. Prof. G. W. Leeper.*
2. A paper dealing with the effects of some elements within the plant—*Dr. T. F. Neales.*
3. "Phosphorus in soils"
   —*Assoc. Prof. G. W. Leeper.*
4. A paper dealing with the interrelationships between rhizobial bacteria in the soil, and between rhizobia and the plant
   —*Mr. J. R. Harris.*

WEDNESDAY, 4th SEPTEMBER.

1. "The importance of latent virus infections and the production of healthy stocks"
   —*Mr. L. L. Stubbs.*
2. "Some aspects of ecology affecting locust control" —*Mr. T. W. Hogan.*
3. A paper dealing with recent advances in genetics in relation to plant breeding
   —*Dr. O. H. Frankel.*
4. "Induced mutation as a tool in plant breeding"
   —*Dr. R. D. Brock.*

THURSDAY, 5th SEPTEMBER.

1. Growth habit as a basis for selecting and breeding new varieties
   —*Miss Yvonne Aitkin.*
2. A paper dealing with the application of a method of forecasting yields in horticultural crops
3. Pasture management in relation to utilisation
   —*Mr. W. M. Willoughby.*

New Mothproofing Process

A new mothproofing process now being recommended by the International Wool Secretariat, was developed in the C.S.I.R.O. Wool Textile Research Laboratories at Geelong. It is known as the SI-RO-MOTH process.

The process uses dieldrin, the most active and persistent insecticide of its type known.

SI-RO-MOTH'D woollen goods are now on the Australian market. At least fourteen major companies are already using the process in Australia and it is being taken up rapidly overseas.

One leading blanket manufacturer has treated all blankets produced for the past 21 months.

The SI-RO-MOTH process is cheap and effective. Treated wool has no odour, and the handle, appearance and physical or chemical properties are unchanged.

The treatment will find its major application for goods which are dry-cleaned or only occasionally washed. It is particularly suitable for outer wear, blankets, floor coverings, felts and furnishings.

C.S.I.R.O. is licensing approved manufacturers to use the name SI-RO-MOTH'D to describe goods treated by the process.

Murray Swamps

In autumn, agriculturists began to assess the damage to S.A.'s fertile River Murray flats as the disastrous floods of last year slowly receded.

A hopeful report comes from Mr. N. E. Stringer of the S.A. Department of Agriculture. He believes the effect of flooding will be less severe than previously thought.

The fertile silt now covering most properties has in many cases made paddocks more level and will reduce irrigation problems, Mr. Stringer estimates. Most farmers plan to cope with badly graded paddocks with barley, oats or temporary pastures until major relevelling work can be completed.

Fallow Sprays to Control Skeleton Weed in Cereals

A new method of combating skeleton weed devised by C.S.I.R.O. offers new hope to cereal growers threatened by this pest. The weed is causing serious losses to farmers in parts of the wheat belt, particularly in New South Wales and Victoria, because it competes strongly with the cereal crop.

The new method involves spraying the weed on the fallow in the autumn, 30 to 50 days before sowing the crop. Accepted present practice is not to spray until the spring.

In the development of the technique, special attention was paid to the competition between weed and crop in the early stages, and it was shown that competition was mainly for nitro-

gen. The deleterious effects on the crop could be largely removed if nitrogen was plentifully supplied.

When soil nitrogen was built up in the soil by three or four years of clover pasture, and the crop grown after a good fallow, the accumulated nitrogen was sufficient for both the crop and weed. No loss in yield due to skeleton weed could then be measured. Sulphate of ammonia or nitrate of soda applied at high rates at seeding also allowed normal growth of the crop, but this method was only economic in the severest cases of weed infestation.

Spraying with commercial "hormone" sprays in spring gave no significant increase in yield, but spraying the weed in the fallow, 30 to 50 days before sowing was found to be as effective as applying 2 cwt. per acre of sulphate of ammonia.

Substantial increases in cereal yields have been obtained in field trials on infested land. In one case, with oats on a very heavily infested field, yields were doubled, representing an increase of 15 bushels per acre. Even on a fertile field sown to wheat, yields were increased by 5 bushels per acre over and above the 25 bushels of the untreated area.

The fallow spray does not affect skeleton weed for very long but allows the crop to get ahead at a critical stage.

As the cost of treatment is only 15/- to 20/- per acre (a fifth of the cost of the nitrogen fertilizers) fallow spraying offers an economic method of increasing yields over the extensive area infested with skeleton weed.

Fallow sprays are now being tested on a number of farms to assess the yield increases possible over a wide range of conditions. Further testing will be necessary before the benefits to the cereal industry can be assessed accurately. At the moment the method shows great promise.

Use of Potash Fertilizers in Australia

A substantial increase in the tonnage of potash fertilizers used on all crops in Australia occurred during 1956. The total of 31,674 tons of both muriate and sulphate used compares with 23,659 in 1954, and 26,724 tons in 1955.

Queensland used approximately half of the 1956 total, mainly on sugar cane and tropical fruits. Victoria was the second largest consumer, pastures accounting for the greater part of the potash used.

The tonnage used in each state during 1956 was as follows:—

N.S.W.	2,705
Victoria	6,156
Queensland	15,741
South Australia	543
Western Australia	4,069
Tasmania	2,460

Victoria and South Australia used approximately 10 times as much potash fertilizer during 1956 as in 1950, while in all other states the tonnage was trebled.

Sugar Conferences

The annual conference of the Queensland Cane Growers' Council was opened in Cairns

ENROLMENTS IN AGRICULTURAL SCIENCE COURSES—1957

University	Year of Course 1	2	3	4	Hons.	Numbers Completed Course 1956 4th Year	Hons.
Adelaide	23	28	16	6	2	10	3
Melbourne	90	34	39	42		19	
Queensland	41	24	14	12		3	
Sydney	90	55	49	28	1	26	
Tasmania	8	—	—	—			
Western Australia	28	10	11	7	6	12	
TOTALS—	280	151	129	95	9	70	3
Associated Courses—							
Wool Technology (Sydney)	N.A.						
Rural Science (New England)	27	15	—	—			
Agricultural Engineering (Melbourne)	—	—	2	3			

Enrolments: 1951-55 See Journal of the Australian Institute of Agricultural Science Sept. 1955, p. 194

1956- See Journal of the Australian Institute of Agricultural Science Sept. 1956, p. 223

on 5th April, 1957, by the Prime Minister of Australia, *Rt. Hon. R. G. Menzies.*

At Meringa Sugar Experiment Station on the day following the opening of the conference, the Queensland Cane Growers' Council formally presented a bronze plaque to the Bureau of Sugar Experiment Stations, as a mark of the cane growers' appreciation of the work of the Bureau in developing measures for the control of the grey back cane beetle.

The nineteenth conference of the Cane Pest and Disease Control Boards was held at Ayr on 16th April, and was followed by a tour of the district for delegates.

Members of the Queensland Branch who attended the annual conference of the Cane Growers' Council in Cairns or the conference of the Cane Pest and Disease Control Board at Ayr, included *Messrs. A. F. Bell, L. G. Vallance, R. W. Mungomery, J. H. Buzacott, C. E. Hughes, B. J. Egan, B. E. Hitchcock, A. G. Barrie, L. S. Chapman, C. C. Brett* and *Dr. J. C. Skinner.*

Visiting Scientists

Dr. G. Donald Sherman, Senior Professor of Soil Science and Chairman of the Department of Agronomy and Soil Science in the University of Hawaii, a visiting Fulbright Fellow, recently arrived in Brisbane. Dr. Sherman will be working with the Agriculture Faculty of Queensland University until August. While in Australia he is studying the nature and genesis of latosolic soils and laterites.

Recent visitors to Canberra have included the following—*Dr. William Davies,* Director Grassland Institute, England, *Professor Martin Jones,* Durham University, *Mr. A. G. G. Hill,* Director Bureau of Pastures and Field Crops, *Professor J. D. Scott,* University of Natal, *Dr. J. R. Cowan,* Oregon State College, *Dr. G. Julen,* Svalof, Sweden, *Dr. W. K. Kennedy,* Professor of Agronomy, Cornell.

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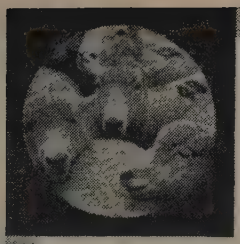

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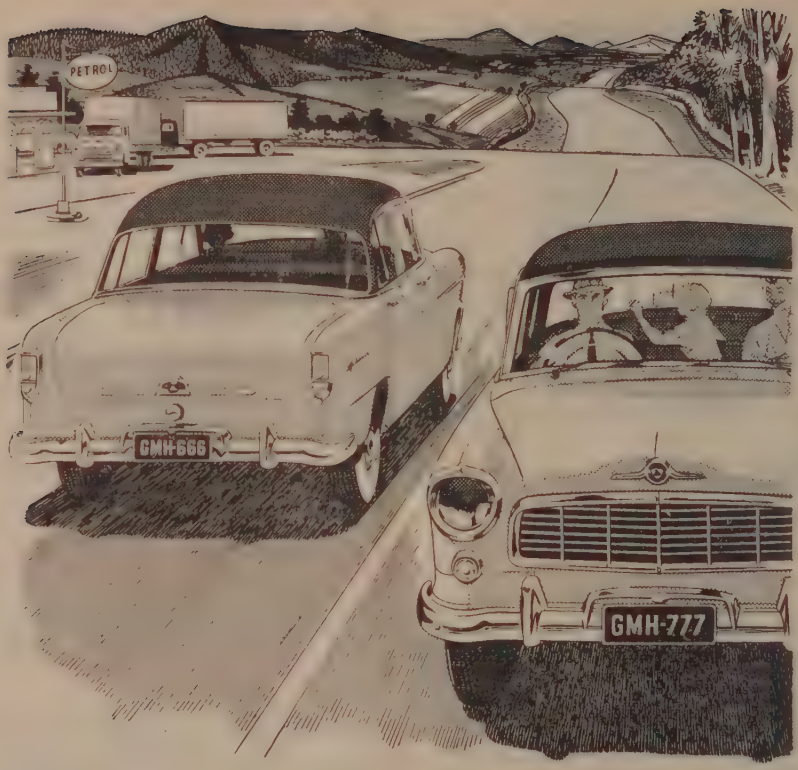

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THE AUSTRALIAN INSTITUTE OF AGRICULTURAL SCIENCE MEDAL

AWARD FOR 1957 TO DR. J. GRIFFITH DAVIES

The Institute Medal for 1957 has been awarded to Dr. J. Griffith Davies in recognition of his outstanding contributions to scientific agriculture within the Commonwealth.

Dr. Davies is Associate Chief of the Division of Plant Industry in the Commonwealth Scientific and Industrial Research Organisation, and is Officer in Charge of the C.S.I.R.O. Plant and Soils Laboratory in Brisbane. He is recognised as one of the world's authorities on grassland research.

In his Presidential address to the Institute in 1952 he produced figures drastically reversing upwards the previously accepted estimates of Australia's stock-carrying capacity. He said that by use of trace elements such as copper, molybdenum and zinc, vast areas of land at present carrying little stock could be made to grow clovers and other legumes.

Experiments had shown that these, in turn, would build up the nitrogen content in the soil and make possible the establishment of pastures capable of carying up to three to five sheep an acre.

Dr. Davies estimated that in Victoria alone 18 million acres of land awaited development by this technique. The figure for New South Wales was 76 million acres, and for Queensland 190 millions acres. Combined figure for the other States was 56½ million acres.

He said that if the trace element-clover-nitrogen formula raised the carrying capacity of the Victorian and New South Wales land by only one sheep an acre, the two States could carry 94 million additional sheep. In Queensland an addition of one head of cattle to each 10 acres would mean a further 19 million head.

Dr. Davies has been responsible for a large part of C.S.I.R.O. research on pastures. Under his guidance the C.S.I.R.O. now has one of the largest grassland research groups in the world.

He has been invited to undertake several F.A.O. missions overseas, and five years ago he went to Pakistan to advise on grassland problems there.

PERSONAL NOTES

Australian Capital Territory

Mr. G. D. Hubble, Regional Soils Officer from Brisbane and *Mr. M. Mulcahy*, Regional Soils Officer from Perth, made a tour through Nowra, Canberra, Wagga, Griffith, and Swan Hill districts discussing soil work in progress in these centres.

Agreement has been reached between the Victorian Department of Agriculture and the Division of Soils C.S.I.R.O. for the re-soil survey of the irrigation settlements of Woorinen, Nyah and Tresco. The original soil surveys were commenced in 1929 and it is likely that the re-survey will turn out a more useful map than the then state of soil knowledge permitted.

Recent new appointees to the C.S.I.R.O. Division of Land Research and Regional Survey are *Mr. R. G. Robbins* and *Mr. J. J. Basinski.*

Mr. Robbins, formerly of the Botany Dept., Auckland University College, has been appointed as ecologist to the New Guinea survey and Mr. Basinski, from the Agricultural Department, Khartoum University has been appointed as ecologist to the mainland survey unit.

Mr. R. W. Prunster has relinquished his position as Officer in Charge of the Regional Pastoral Laboratory at Deniliquin and has been seconded to the Commonwealth Bank where he is assisting in the establishment of a rural advisory section.

New South Wales

The Dean of the Faculty of Agriculture, *Professor J. R. A. McMillan*, presented the degrees at the graduation ceremony at Sydney University on 2nd May. The degree of D.Sc.Agr. was conferred on *Spencer Smith-White*; degrees of Ph.D. were conferred on *Messrs. J. S. Bunt* and *A. D. Rovira.* M.Sc.Agr. degrees were awarded to *M. W. McDonald, W. R. Stern, J. W. McGarity, R. G. Marquez* and *K. J. Scott.* Pass degrees were conferred on 21 graduates, whilst three Honours degrees were awarded, 1st Class to *Miss Ann Gregory* and *Mr. E. Vitols*, 2nd Class to *Mr. P. L. Coleman.*

Dr. F. T. Bowman has been appointed Chief, Division of Horticulture, in the N.S.W. Department of Agriculture. Dr. Bowman, who was formerly Principal Fruit Officer (Research) has recently released three cherry varieties arising

from his fruit breeding programme, and has published a book on citrus growing in Australia.

Honorary Secretary of the Northern Sub-Branch, *Mr. J. M. George*, has supplied news of three of their members.

Mr. B. V. Fennessy, of the Wildlife Survey Section, C.S.I.R.O., recently returned to Armidale from New Zealand. The main purpose of his visit was to study the methods and organisation involved in the control of rabbit populations under the "Killer Policy" which has been implemented so effectively in the Dominion. He was greatly assisted by the Rabbit Destruction Council—the national body advising and supervising district Rabbit Boards—and also by numerous Boards. Mr. Fennessy had an opportunity of studying methods being developed to cope with opossums introduced from Australia and now considered to be causing extensive damage to forests.

Mr. K. Spencer has recently returned to Armidale after an absence overseas of 15 months. He was awarded a Fulbright Travel Grant to enable him to study for a Master of Science degree in Agronomy (Soils) at Mississippi State College. The title of his thesis is "Growth and Composition of White Clover as affected by the Sulphur and Phosphorous Supplies." Mr. Spencer visited a number of centres in southern and western U.S.A. where research on Sulphur as a plant nutrient was in progress. He also attended the 7th International Grasslands Congress in New Zealand on the return route.

Dr. R. F. Passey recently took up duties as Lecturer in Biochemistry at the University of New England, Armidale. He obtained his Ph.D. degree from the Institute of Parasitology, McGill University, Montreal, Canada, where he worked for three years under the auspices of the National Research Council of Canada. His doctorate was awarded for work carried out on certain biochemical aspects of the parasitism of the intestinal round-worm of pigs and man.

Mr. H. W. Lea, is travelling to U.S.A. to study tobacco breeding for six months at the University for Post-graduate Workers, North Carolina. *K. J. Scott* is at present in Canada; *Miss Vinleigh Johnson* is making a private tour of Great Britain and the Continent.

Mr. A. S. Peterson and *Mr. R. W. Gartrell* have resigned from the N.S.W. Department of Agriculture. Mr. Peterson, a past Secretary of the Branch, was Pasture Agronomist with the Division of Plant Industry and was for a time Acting Agronomist, Miscellaneous Crops. Mr. Gartrell resigned as Fruit Research Officer at Bathurst Experiment Farm to tour Germany and Great Britain.

The N.S.W. Department of Agriculture has appointed two further new graduates, *Mr. P. Cable* to the Biological Branch and *Mr. T. Bourke* to the Entomological Branch.

Victoria

Mr. N. M. Tulloh, formerly of the Animal Health Division of C.S.I.R.O., has been appointed Senior Lecturer in Animal Husbandry at the University of Melbourne.

Mr. R. Harper, formerly Manager of Tatura Horticultural Research Station is now Senior Inspector of Horticulture at Head Office, Melbourne.

Mr. R. H. Macdonald has resigned from the Department of Agriculture to take up a position with Potash (Aust.) Pty. Ltd.

There were nineteen graduates from the School of Agriculture, Melbourne, at the end of 1956. These graduates have taken up positions as follows—

Department of Agriculture, Victoria:—
Messrs. G. N. Arthur, O. I. Bissett, B. C. Curnow, K. J. Edwards, G. O. Jones, J. Vercoe.
Soil Conservation Authority, Victoria:—
Messrs. F. X. Dunin, W. R. Rothols.
C.S.I.R.O.:—
Miss M. Elder, Miss B. Hall.
Dept. of Territories, New Guinea:—
Mr. W. R. Stent.
Dept. of Lands, Victoria:—
Mr. B. G. R. Woodfield.
Research workers at School of Agriculture, Melbourne University:—
Miss J. Billing, Messrs. J. B. Coomb, J. W. C. Morrison.
Research worker at School of Physiology, Melbourne:—
Mr. J. R. Sabine.

Queensland

Dr. N. T. M. Yeates, has left Brisbane to take up the position of associate Professor of Livestock Husbandry in the University of New England, Armidale. Previous to this appointment Dr. Yeates was employed by C.S.I.R.O. and worked at the Department of Physiology, University of Queensland studying the effects of environment in animal physiology.

Mr. R. Menary, Plant Physiologist with the Queensland Department of Agriculture and Stock, has been awarded a Rotary Fellowship which will enable him to spend a year studying plant moisture relationships at the University of California. Mr. Menary plans to commence his studies at Davis during September, 1957.

Mr. D. J. Sellar, a graduate of Sydney University, has been appointed to the Queensland Department of Agriculture and Stock. Mr. Sellar is spending six months in Brisbane preparatory to working on pasture improvement in Western Queensland.

Miss D. E. Nunn and *Mr. J. K. Leslie*, who recently graduated in Agricultural Science, have also joined the Department of Agriculture and Stock. Miss Nunn is attached to the Sheep and Wool Branch and Mr. Leslie has been appointed as Agrostologist at Toowoomba.

Mr. J. E. C. Aberdeen, of the Botany Department, University of Queensland has sailed for England on a year's study leave.

South Australia

The Degree of Doctor of Philosophy was awarded recently to last year's treasurer, *Dr. N. C. Crowley* and to *Dr. C. Pannabokke*, by the University of Adelaide.

Dr. R. K. Morton took up his appointment as Professor of Agricultural Chemistry, Waite Institute, University of Adelaide late in April.

Dr. R. J. Swaby, of C.S.I.R.O., has been granted study leave during 1958. While away, he hopes to visit U.S.A., Europe and the U.S.S.R.

Dr. J. Melville, Director of the Waite Institue has been appointed the representative of the University of Adelaide to the Council of the Australian Wine Research Institute.

Mr. R. J. Millington, of the Waite Institute, is in London working with Professor Gregory at the Imperial College of Science, London.

Mr. D. E. Symon has returned to the Waite Institute after 12 months study leave.

Dr. N. T. Flentje, at present in America, attended a conference of plant pathologists at Cincinnati recently before moving to Lethbridge, Canada.

Messrs. J. V. Ellis, C. Watson, J. Potter and *M. I. H. Brooker* have been appointed to the Department of Agriculture.

Dr. R. L. Specht, Adelaide University Botanist, returned from a U.S. trip after examining arid zone research there.

Students this year in S.A. number 25 in first year, 25 second year, 16 third year, 6 fourth year, with 2 honours students.

BRANCH NOTES

Australian Capital Territory

The 128th General Meeting of the A.C.T. Branch was held at the C.S.I.R.O. Lecture Theatre at Black Mountain on the 11th April, 1957. The President, *Dr. Williams* was in the Chair and 26 members and visitors were present.

Congratulations were extended by the President on behalf of the Branch to *Drs. A. J. Anderson* and *R. F. Williams* on their Doctorates.

The President reported upon the Annual General Meeting of the Institute and upon the Council Meeting he attended.

Mr. Shaw then delivered his address entitled "The use of Aircraft in Agricultural Operations".

At the conclusion of the talk the subject was opened for discussion. Mr. McLennan recounted some of the practical difficulties in aerial seeding and top dressing. Dr. Frankel suggested that there should be a co-ordinating body to advise the operators on techniques and to experiment with methods of top dressing and spraying.

A film obtained from the Victorian Department of Agriculture entitled "Operation Grasshopper" was then shown.

New South Wales

At the Annual General Meeting of the Branch held in February the following office-bearers were elected to the Committee of Management for 1957.

President: Dr. R. L. Reid.
Vice President: Dr. M. C. Franklin.
Honorary Secretary: Mr. E. H. Jacob.
Honorary Assistant Secretary: Miss J. Quigan.
Honorary Treasurer: Dr. D. A. Lewis.
Members of Committee: Mr. A. N. Johnston, Mr. J. D. McFarlane, Associate Professor J. M. Vincent, Professor T. J. Robinson, Mr. A. J. McIntyre.
Honorary Sub-Editor: Mr. W. Greenhalgh.

The retiring President, Dr. M. C. Franklin, in his presidential address reminded members of some of the more important current activities of the Institute and discussed certain problems affecting both the Institute and agriculture generally.

Assistance is being given to the Society of Agricultural Education, recently established at Bathurst, in those of its activities which parallel the aims and activities of the Institute.

A dinner was arranged by the Branch for the members and visitors attending the Annual General Meeting of the Institute held on 14th March. The Branch President, Dr. R. L. Reid, welcomed visitors from other States and extended a special welcome to Professor J. P. Baxter, Vice-Chancellor, University of Technology, and Chairman of the Atomic Energy Commission, and Dr. R. Bradfield, Chairman, Department of Agronomy, Cornell University, U.S.A.

The main business of the Branch Meeting held on 12th April was a symposium entitled "The Impact of Recent Research on Pasture Improvement in N.S.W." The leading speakers were Messrs. F. W. Craddock (Plant Nutrition Chemist), W. T. Atkinson (Pasture Agronomist) and K. Marshall (Bacteriologist), all members of the Plant Nutrition Group of the N.S.W. Department of Agriculture.

A cocktail-party organised jointly by the Branch and the Sydney University Agricultural Graduates Association was held at the University on graduation day, 2nd May, to welcome new graduates to the Institute and Association. A total of 55 graduate guests, members and visitors attended. The Branch President, Dr. R. L. Reid, congratulated the new graduates on attaining their degrees and invited all to become members of the Institute.

Victoria

The first Branch meeting for 1957 was held at the School of Agriculture on March 22nd, when members were addressed by Mr. F. Penman, Senior Officer-in-Charge, C.S.I.R.O. Irrigation

Research Stations, who recently attended an F.A.O. irrigation study tour of Russia as an observer for the Department of External Affairs.

With the assistance of a series of excellent slides, Mr. Penman presented an interesting travelogue on many of the U.S.S.R. republics. He described developments in irrigation equipment and practices, management of State and collective farms and also many places and buildings of interest, such as the Kremlin, Bolshoi Theatre, etc.

A second meeting of the Branch was held at the University on April 2nd, when Mr. W. R. van Dersal of the U.S. Soil Conservation Service spoke to a small gathering of members and visitors. Mr. van Dersal, who began his career as a botanist, is the Deputy Administrator of the S.C.S., an authority which is concerned with both soil and water conservation.

The 22nd Annual General Meeting was held on the 31st May. The retiring President, Mr. C. E. Cole, delivered an address entitled "A review of Victorian Horticulture".

Details of this meeting will appear in the September issue of the Journal.

Queensland

The Annual General Meeting of the Queensland Branch was held in the Department of Agriculture, University of Queensland on 27th March. The following office-bearers were elected for 1957:—

President: Mr. N. H. Shaw.
Vice-Presidents: Dr. D. O. Norris and Professor L. J. H. Teakle.
Hon. Secretary: Mr. L. A. Edye.
Hon. Asst. Secretary: Mr. A. G. A. Eyles.
Hon. Treasurer: Miss M. L. Moffett.
State Sub-Editor: Dr. E. F. Henzell.
Committee Members: Mr. G. D. Hubble, Mr. J. R. M. Wolfe and Mr. K. M. Ward.

The Presidential Address entitled "The History and Development of the Faculty of Agriculture, University of Quensland," was delivered by *Professor L. J. H. Teakle.* Professor Teakle, who is the first full-time Professor of Agriculture in the University, described the establishment, development and future objectives of the Faculty.

The 137th ordinary General Meeting of the Branch was held on Wednesday, 14th April. An illustrated address on "Rhodesia and Some Aspects of its Agriculture" was given by *Mr. H. D. L. Corby.* Mr. Corby, who is in Australia on an F.A.O. Fellowship, is Officer-in-Charge of the Grasslands Research Station at Marandellas in Southern Rhodesia. He is spending three months at the Plant and Soils Laboratory in Brisbane and will later visit the Southern States and New Zealand. In his address Mr. Corby gave a general description of Rhodesian agriculture and discussed some of the pasture problems which are encountered at Marandellas.

South Australia

The annual general meeting of the S.A. branch was held in March. *Professor C. M. Donald,* of the Waite Institute, University of Adelaide, was elected president for 1957. Last year's president, *Mr. A. J. K. Walker,* Chief Agricultural Adviser of the Department of Agriculture becomes the 1957 vice-president. *Dr. E. L. Greacen,* of C.S.I.R.O., is the new Hon. Secretary, with *Mr. M. B. Spurling* Hon. Treasurer and *Mr. C. T. Griffith* as Hon. Sub-Editor. Committee members are: *Dr. J. Melville, Mr. P. C. Angove, Dr. G. M. E. Mayo* and *Mr. J. C. M. Fornachon.*

In April the branch held a cocktail party at the Graduates Room, University of Adelaide. The purpose was to welcome and recruit new members, and to bring old members together. About 40 members attended and the Branch hopes to make the cocktail party an annual one.

Western Australia

During recent months, two very interesting papers have been presented to members at local Branch Meetings. On both occasions the lecturers had only recently returned from study tours overseas, and it appears obvious that members enjoy papers dealing with agriculture and research in foreign countries.

On February 28, Mr. P. G. Ozanne, a research worker at the Institute of Agriculture, delivered a lecture entitled "Recent Research on the Requirement of Plants for the Halides—Chlorine, Bromine, Iodine and Fluorine." This talk traced the story of the role of the Halides in plant nutrition, and was illustrated by excellent colour slides. These slides were taken by Mr. Ozanne at the University of California, U.S.A., during the course of his studies.

The most recent paper was presented on April 1 by Mr. A. M. Stewart, the Assistant Director of the Institute of Agriculture. Mr. Stewart has just returned from a study tour of Spain, Portugal, Britain and Scandanavia. His talk entitled, "The Agriculture of Spain and Portugal" was well illustrated by colour slides. This area is of special interest to those of us who inhabit Mediterranean climatic regions, and the talk clearly pictured the poverty and social problems associated with these countries of the Old World.

Tasmania

The Annual General Meeting of the Tasmanian Branch of the Institute was held on Tuesday, 26th March. A pleasing (and unusual) feature of the meeting was the presence of a strong contingent of Northern members. There was an almost 50% attendance of Branch members.

Officers elected were as follows:—

President—I. D. Geard.
Vice-President—D. Berry.
Secretary—K. M. Stackhouse.
Assist. Sec.—P. G. Williams.
Treasurer—K. W. N. Dillon.
Journal Sub-Ed.—J. R. Ward.
Publicity Officer—B. D. Millar.
Committeemen—Prof. H. N. Barber; J. H. Wilson.
Hon. Auditor—L. R. Pyke.

The Branch Balance Sheet showed a marked improvement in Branch finances. The Branch levy for 1957 was fixed at 11/6 (making a total subscription of £4/5/-). An amendment reducing the Branch levy to 6/6 was defeated.

The subject of Professor Barber's presidential address was "The Control of Flowering". This paper is being submitted for later publication in the Journal.

The Committee has appointed Mr. L. W. Miller as the Institute's representative on a sub-committee of the Council of the University of Tasmania. The purpose of this sub-committee is to investigate the possibility of establishing a Faculty of Agriculture in the University. Mr. K. D. Nicolls, representing C.S.I.R.O. and Professor Barber are also members of this sub-committee.

Branch views and opinions will be sought at a general meeting.

APPOINTMENTS AVAILABLE — *See also pages 137, 143, 148, 167, vii.*

PUBLIC SERVICE OF TASMANIA

Applications, addressed to the Public Service Commissioner, Public Buildings, Murray Street, Hobart, are invited for the following positions to which appointments will be made in accordance with the provisions of the Public Service Act:—

DEPARTMENT OF AGRICULTURE

District Horticultural Officer.

Salary range—£1402-1657 per annum, inclusive of cost of living allowance.

Duties—Organise district horticultural extension activities in relation to the production of horticultural crops. Duties under the Plant Diseases Act. Investigate applications for financial assistance. Supervision and report on properties receiving financial assistance.

Assistant District Horticultural Officer.

Salary range—£1062-1402 per annum, inclusive of cost of living allowance.

Duties—To assist in providing an advisory service to producers of horticultural crops, instructional work with propagation, pruning and presentation of crops for market, horticultural surveys and assistance to extension and research officers.

Qualifications—Applicants should possess a Degree in Agricultural Science or Diploma of a recognised Agricultural College or equivalent qualifications. In the case of the District Horticultural Officer a wide experience in horticultural production, costing and valuations will be necessary.

Transport—Appointees may be required to provide cars for official travelling, for which mileage allowance in accordance with Public Service Regulations is payable. Financial assistance is available for the purchase of a car.

PUBLIC SERVICE OF TASMANIA

Applications, addressed to the Public Service Commissioner, Public Buildings, Murray Street, Hobart, are invited for the following positions, to which appointments will be made in accordance with the provisions of the Public Service Act:—

DEPARTMENT OF AGRICULTURE

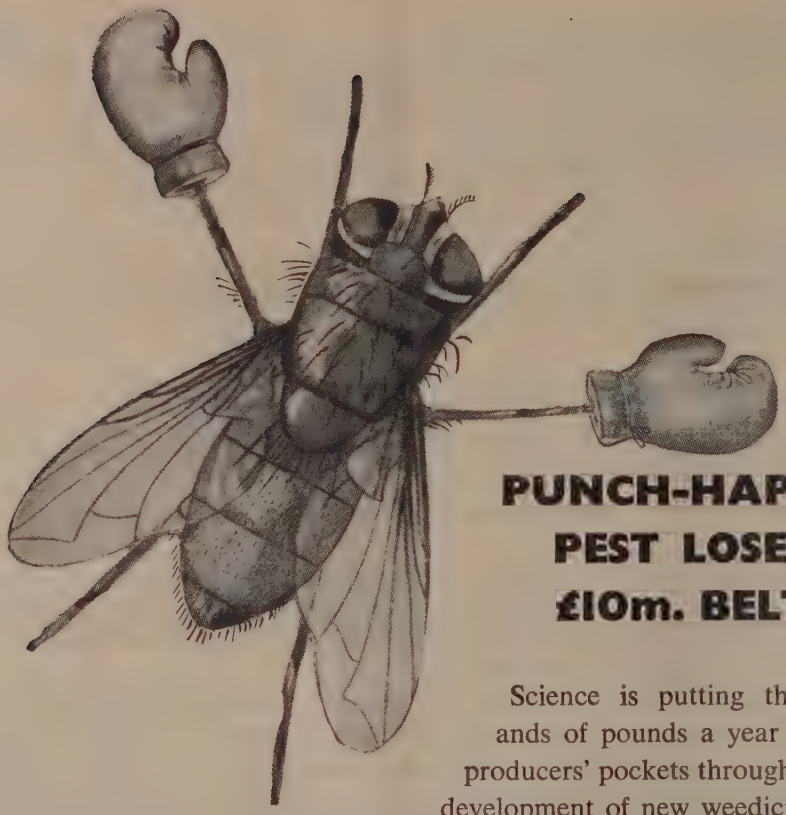
Bio-Chemist (Male).

Salary range—£1,504-£1,657 per annum, inclusive of cost of living allowance.

Duties—Will include routine diagnostic work and survey work particularly associated with trace element deficiencies, in the first instance. The successful appointee will be expected to organise the establishmnt of a laboratory and to train and direct the work of junior technical staff not yet appointed. Opportunities will be available for research work.

Qualifications—A University Degree in Science, preferably with honours, and with a sound background in the biological sciences. Preference will be given to applicants with bio-chemical experience.

Appointee will be required to provide his own car for which an allowance is paid for official travelling.



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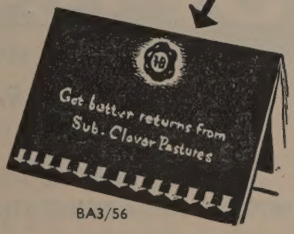

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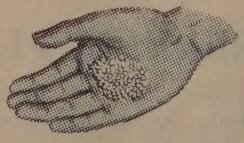

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Division of Animal Health and Production

APPOINTMENT OF IMMUNOLOGIST

Applications are invited for an appointment to a position with the Division of Animal Health and Production, at the Veterinary Parasitology Laboratory, Yeerongpilly, Queensland.

At Yeerongpilly, the Organization is carrying out research into helminths and ticks infesting cattle. The appointee will investigate host reactions to these parasites and good experience in the application of the principles and techniques of immunology will be required. Although the work will be with helminths and ticks, a knowledge of these parasites is not essential and due consideration will be given to applicants whose experience in immunology has been in other fields.

Applicants should possess an honours degree in Veterinary Science, Science, Agricultural Science or equivalent qualifications together with appropriate post-graduate research experience.

Dependent upon qualifications and experience, commencing salary will be determined within the salary ranges of Research Officer (£A1287-£A1912) or Senior Research Officer (£A2022-£A2297). First class sea fares will be paid for an overseas appointee with his wife and family.

The appointment will be conditional upon a satisfactory medical examination and the successful applicant may be required to serve an initial probationary period of up to twelve months before being confirmed in his appointment as an officer of the Organization. If so confirmed, he will be required to contribute to and eligible to receive benefits from either the Commonwealth Superannuation Fund or the Commonwealth Provident Account.

Applications, quoting reference number 204/40 and stating full name, place, date and year of birth, marital state, present employment, particulars of qualifications and experience and of war service, if any, accompanied by copies of not more than four testimonials, should reach the Officer-in-Charge, Veterinary Parasitology Laboratory, C.S.I.R.O., Yeerongpilly, Queensland, Australia, by 15th July, 1957.

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